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ABSTRACT

The activities comprising the career education resource guide explore careers in chemistry or chemistry-related fields with limited treatment given to other science-related occupations. Units providing a general framework of chemical principles and related activities alternate with the career units. The career concepts most applicable to each unit are given with the unit. The Acquisition of Career-Entry Skills, Stage 5 of the Louisiana State Plan for Career Education, is emphasized. Information and experience built into the curriculum and into the career education activities are intended to help the student acquire these career-entry skills. A list of these skills is given for each unit. Making up one-third of the document, the appendix lists chemistry textbooks adopted for use in Louisiana schools; a reference code; instructional materials; lists of careers in, or related to, science and technology; an occupational study outline; and a list of information sources. (Author/NJ)

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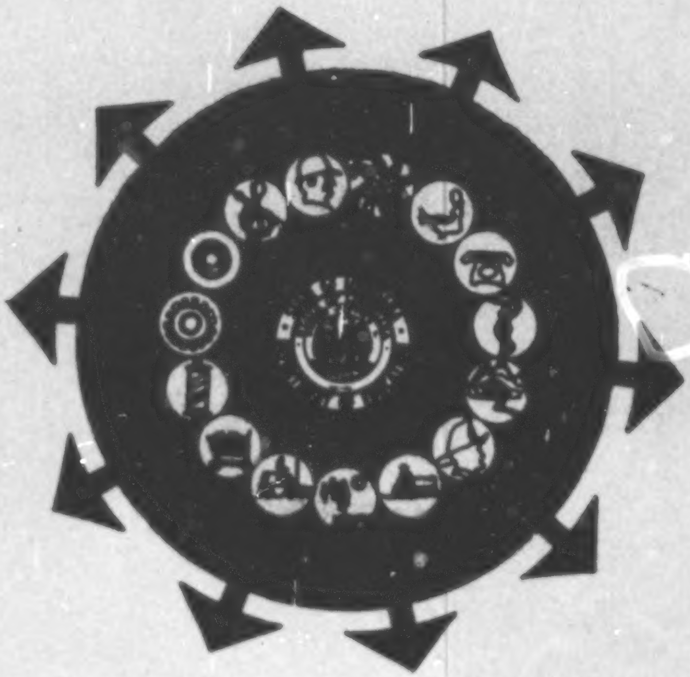

CAREER EDUCATION RESOURCE GUIDE FOR CHEMISTRY

1974
LOUIS J. MICHOT
STATE SUPERINTENDENT OF EDUCATION

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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FOREWORD

TO USE THIS GUIDE

This guide is not intended to impose rigid uniformity nor is it intended to substitute for inventiveness and discretion on the part of the teacher. It is the professional responsibility of the teacher to make choices in the best interest of his individual students. The subject of Chemistry is broad enough to allow for fruitful diversity in its teaching. The teacher is urged to design activities appropriate to his particular circumstances, and to take advantage of his own strengths and preferences.

This guide provides a general framework of chemical principles and related activities. Descriptive chemistry is arranged around this central structure.

The only textbooks cited as references are those on the Louisiana State Department of Education list of adopted texts. It is suggested that the teacher secure at least one copy of each of these. They, along with the accompanying laboratory guides and addresses, are listed in Appendix I.

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INTRODUCTION

CAREER EDUCATION UNITS

The development of career education as related to a chemistry course is centered around Stages III, IV, and V of the State Plan for Career Education. These stages are, respectively, Career Exploration, Tentative Career Decisions, and Acquisition of Career-Entry Skills. (A complete list of the stages and related career concepts is given in the introductory material.)

The suggested activities explore careers in chemistry or chemistry-related fields mainly; however, other science related careers are given limited treatment. Chemistry is so pervasive that any list of places where chemists work is almost certain to be incomplete. This unit is not meant to be exhaustive - teachers can feel free to add any materials which they consider relevant. The career concepts which are most applicable to each unit are given with each unit.

More career activities are given than any one teacher will be able to use. This will allow the teachers to be selective - and they can add any activities, particularly any that would utilize local resources. Each unit is meant to be flexible. Most of the activities are student activities rather than classroom in order to conserve classroom time for curriculum studies.

The Acquisition of Career-Entry Skills, Stage v, for students going from high school into employment or into advanced study and training has been emphasized. Information and experience built into the curriculum and into the career education activities are intended to help the student acquire these career-entry skills. A list of these skills is given for each unit.

For the convenience of the teachers and students using this unit, the addresses of all resources mentioned are listed alphabetically in Appendix VII. Most of the pamphlets listed as resources are free. (Allow several weeks for delivery.)

The following list of the unit titles will indicate the development plan. Units XI thru XVIII are parallel in development and can easily be rearranged, developed simultaneously, or even omitted without affecting the overall plan.

I. Students and Guidance Resources
II. Student Abilities, Interests, Needs, and Values
III. Science Related Careers
IV. Women and Science Careers
V. Tentative Career Selections
VI. Careers in Technology
VII. Chemical Technician Careers
VIII. Chemistry Careers
IX. Employment Outlook for Chemists
X. Chemistry Related Careers
XI. Atomic Energy Careers
XII. Careers in Biological Sciences
XIII. Engineering Professions
XIV. Environmental Careers
XV. Careers in Medicine, Dentistry, Veterinary Medicine
XVI. Medical Technology, Nursing, and Health Careers
XVII. Pharmacy Careers
XVIII. Science and Chemistry Teaching Careers
XIX. Reporting on Tentative Career Selections
XX. Communicating Information to Others
XXI. Student Evaluation of Career Exploration and Acquisition of Career-Entry Skills.

CAREER CONCEPTS AND OBJECTIVES: A SEQUENTIAL PLAN

STAGE **GRADE**

I. CAREER AWARENESS — K-3

Concepts:

1. The individual is the born resource of society
2. Individuals have many kinds of careers
3. Meaningful, rewarding careers are available to every individual

II. CAREER MOTIVATION — 2-6

Concepts:

4. Work is basic to human development
5. Occupations contribute to society's progress
6. Careers require different knowledge, abilities, attitudes and talents
7. Individuals have different abilities, interests, needs, and values
8. Individuals seek careers for varied reasons

III. CAREER EXPLORATION — 5-9

Concepts:

9. Environmental variability creates variable opportunity
10. Careers can be grouped into clusters
11. Different careers are interrelated
12. Every career requires some special preparation and a plan of special preparation facilitates this

IV. TENTATIVR CAREER DECISIONS AND EXPLORATION — 8-10

Concepts:

13. Individual careers may change as individuals change throughout life
14. Individuals may be suited for several different careers
15. Individuals adapt to world changes and environment
16. World changes, conditions, and environment affect careers

V. ACQUISITION OF CAREER-ENTRY SKILLS AND CONTINUED EXPLORATION — 9-12

Concepts:

17. Careers require different levels of competence in communication, computation, and analysis
18. Careers have different levels of competence and responsibility
19. Rules, regulations, policies, and procedures affect individuals in all careers
20. Careers are affected by the ability of individuals to relate to each other

CAREER EDUCATION IN LOUISIANA
AN EXPERIENCED-BASED, SEQUENTIAL PLAN

STAGE I	CAREER AWARENESS (Grades K-3)
STAGE II	CAREER MOTIVATION (Grades 2-6)
STAGE III	CAREER EXPLORATION (Grades 5-9)
STAGE IV	TENTATIVE CAREER DECISIONS (Grades 8-10)
STAGE V	ACQUISITION OF CAREER-ENTRY SKILLS (Grades 9-12) (Differential Programs)
STAGE VI	CAREER ENTRY

A. EMPLOYMENT
   FURTHER STUDY AND TRAINING

B. SPECIALIZED STUDY AND TRAINING
   EMPLOYMENT
   FURTHER STUDY AND TRAINING

EACH STAGE REQUIRES:

INFORMATION
EXPERIENCE

WHICH LEADS TO:

FIRST-HAND PERSONAL LEARNING

WHICH LEADS TO:

SELF-DEVELOPMENT

WHICH LEADS TO:

INDIVIDUAL SUCCESS

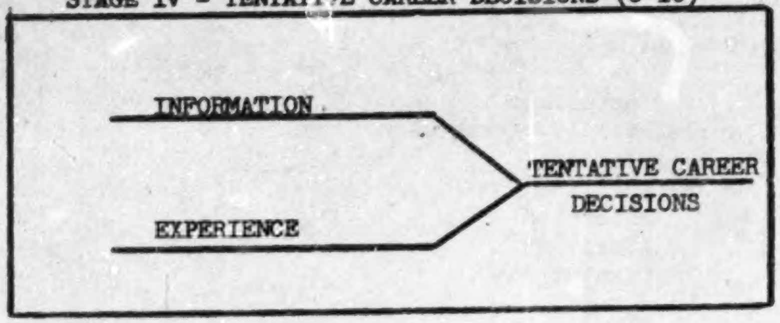
WHICH LEADS TO:

A HEALTHY SENSE OF WELL-BEING

CAREER EDUCATION IN LOUISIANA

AN EXPERIENCE-BASED, SEQUENTIAL PLAN

STAGE IV - TENTATIVE CAREER DECISIONS (8-10)



INFORMATION

- Guided self-analysis
- Structured job-oriented curriculum
- Analysis of employment trends (national, regional, and local)
- Projections of post-school possibilities in view of changes and newest developments (social, government, industrial)

EXPERIENCE

- Mock industries; life-career games
- Local analyses and projections in relation to self-interests and abilities
- Role Playing: labor-management relations; professional-client relationships; family's responsibilities in today's world
- Making of tentative career decisions: developing individual projections

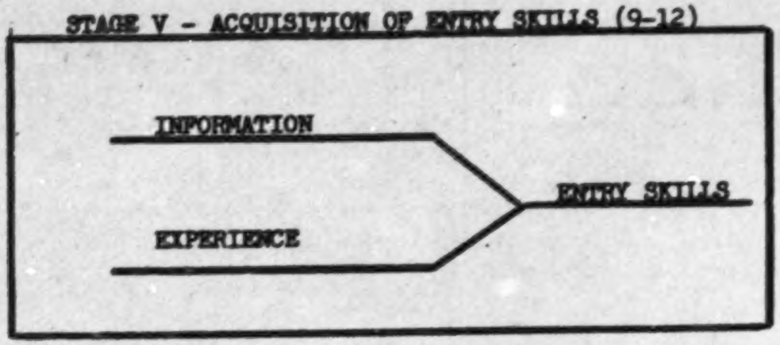
OBJECTIVE = TENTATIVE CAREER DECISIONS =

Focusing career options on a few realistic possibilities

CAREER EDUCATION IN LOUISIANA

AN EXPERIENCED-BASED, SEQUENTIAL PLAN

STAGE V - ACQUISITION OF ENTRY SKILLS (9-12)



INFORMATION

Studies in:

Major disciplines
Ethics, Values, Aesthetics
Human relations
Social institutions
Self: Interests
Abilities
Limitations

EXPERIENCE

Opportunities to validate tentative decisions made in Stage IV
Hands-on training geared to individual plans
Cooperative study of specific businesses, industries professions, arts, and the environment
Activities leading toward accurate self-appraisal and practice of interpersonal dynamics
Student study of employer expectations

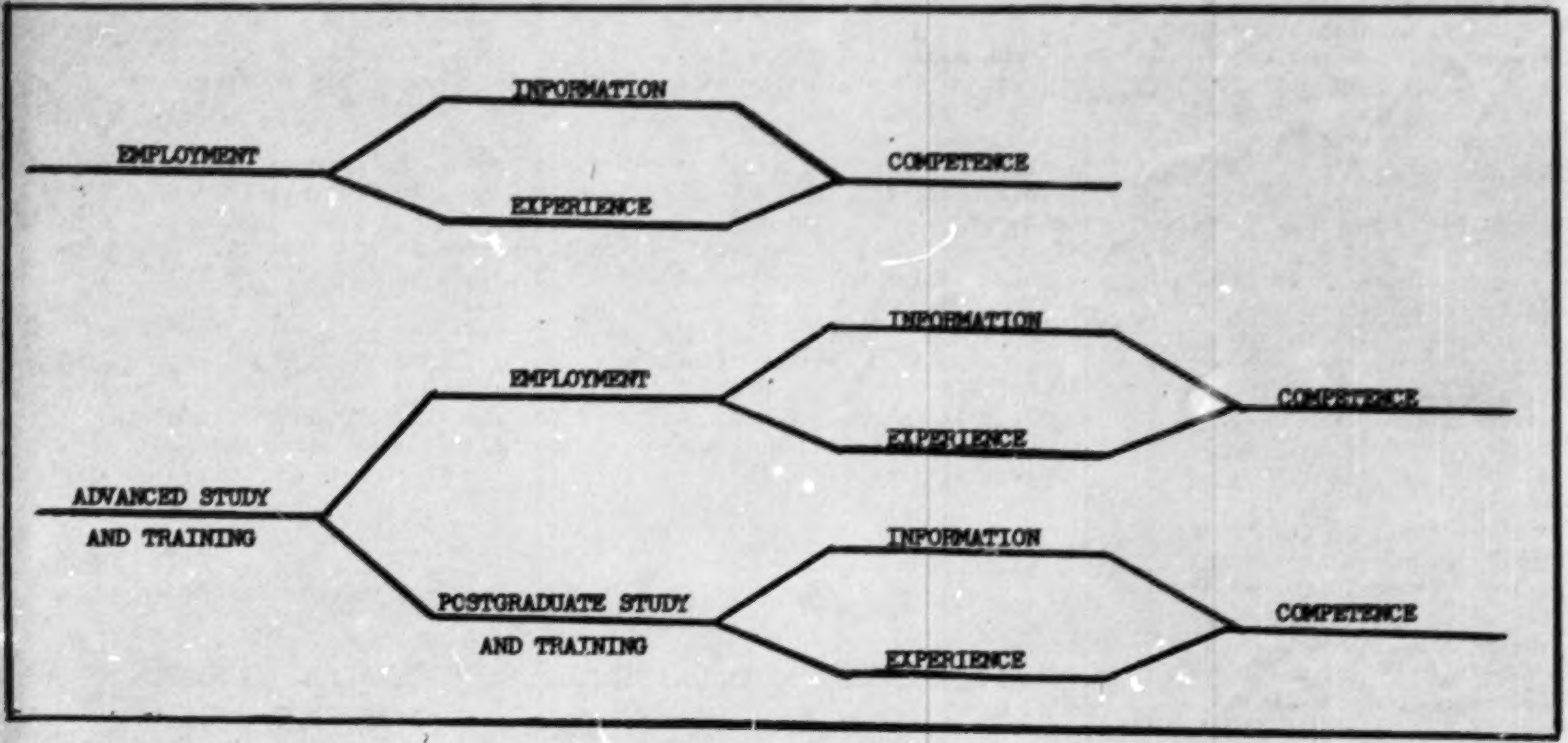
OBJECTIVE = ENTRY SKILLS for employment or advanced study and training =

Understanding and acceptance of basic work habits and attitudes; competence in reading, computation, writing, analysis; desirable attendance, punctuality, dress, and grooming; pride in quality of work and study

CAREER EDUCATION IN LOUISIANA

AN EXPERIENCE-BASED, SEQUENTIAL PLAN

STAGE VI


EMPLOYMENT
INFORMATION
EXPERIENCE
COMPETENCE
ADVANCED STUDY AND TRAINING
EMPLOYMENT
INFORMATION
EXPERIENCE
COMPETENCE
POSTGRADUATE STUDY AND TRAINING
INFORMATION
EXPERIENCE
COMPETENCE

CONTENT AND INTENT

Chemistry is a very human activity. The term "scientific method" describes the methods used by people who are now contributing to our store of knowledge. Among the activities that seem to be common to productive research are observing, organizing, looking for regularities and inventing logical models to explain the regularities.

Theories (models) need not be correct in every context to be useful in a limited context. There is no assurance that a law established or a theory found to be useful within a certain range of experience can be validly extrapolated outside the range. Extrapolation does, however, lead to predictions which, in turn, can be tested by experiment.

We should expect that, in the future as in the past, models accepted in the light of our present limited experience may be changed or discarded in the light of new information. They will be replaced by more useful models as our experience expands.

OBJECTIVES

The student should (or should be able to):

1. Distinguish between observations and inferences. Make judgements about degree to which observations are quantitative.

*2. Make a list of observations about an event. (Davis '68 pp 1,2,123; Cotton '73 p 5; Carmichael '71 p 19; Tellifsen '70 p 104; Ledbetter '73 p 21)

3. Use the work of a selected scientist and/or the story of an important discovery to illustrate the elements common to "Scientific Method."

*4. Organize data in data tables and/or express it graphically. Interpret data tables and graphs. (Cotton '73 pp 7,13; Bickel '71 p IX)

*5. Devise a logical explanation about an observed regularity. Test it on a related system. (Turner '74 p 28; Cotton '73 p 21)

6. Discuss the degree and quality of confidence that can be placed in models (theories) as compared to that placed in observations and regularities.

An asterisk (*) indicates an objective for which "hands on" experience is suggested.

References are given to clarify the intent of the objective. A code to references cited is found in Appendix I-B: All references are to 1973 Louisiana State Department of Education textbook adoptions. (Appendix I-A)

CAREER EXPLORATION AND TENTATIVE CAREER DECISIONS
ACQUISITION OF CAREER-ENTRY SKILLS

UNIT I - STUDENTS AND GUIDANCE RESOURCES

CAREER CONCEPTS

10. Careers can be grouped into clusters
11. Different careers are interrelated

OBJECTIVE

Students become familiar with resources in Guidance which can be used in independent research on careers in science and chemistry.

ACTIVITIES

Schedule a meeting of the class with a Guidance Counselor. The Counselor should discuss available material, where it is located, and how to make use of it. Include information on
- Audio Visual aids on careers
- Careers in general
- Science related careers
- Chemistry related careers
- Directories of colleges and technology schools
- Catalogs from some of the above schools
- Information on careers that offer apprenticeship training for high school graduates

CAREER-ENTRY SKILLS ACQUIRED IN THE CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Ability to locate, organize and use resource material
Observe, record data, organize and evaluate data

RESOURCES

Films, filmstrips on Careers

Barron's Profiles of American Colleges
Vol. 1: Descriptions of the Colleges
Vol. 2: Index to Major Areas of Study
Barron's Educational Series, Inc.

Comparative Guide to Two-Year Colleges and Four-Year Specialized Schools & Programs - Harper & Row, Pub.

Career Counseling - Yearbook T&I Div.
American Vocational Assn. (Amer. Technical Society)

On the Job Training and Where to Get It - Julian Messner

Guide to Professional Careers - Julian Messner

Careers and Opportunities in Science - Pollack, E. P. Dutton & Co.

Comparative Guide to Programs in Biological Sciences and Chemistry, Harper & Row, Pub.

Opportunities in the Chemical Sciences - John H. Woodburn - Vocational Guidance Manuals

Opportunities in Environmental Careers - Odom Fanning - Vocational Guidance Manuals

NOTE: These are books or manuals which Guidance may have. They can be replaced or supplemented with similar information. The address of each of the above publishers is listed in Appendix VII. (There is a charge for each.)

II MATTER AND ENERGY

CONTENT AND INTENT

Chemistry deals with the fundamental concepts of matter, its properties, its changes and the energy associated with its changes. One of the most fundamental laws governing these changes is the law of conservation of mass-energy. Einstein equates energy and mass through the equation $E=MC^2$. Nuclear reactions involve significant interchanges between mass and energy, but chemical reactions do not.

Some concepts associated with matter are mass, volume, and the ratio derived from them, density. The common states of matter are solid, liquid, and gas. Most substances can, under proper conditions, exist in any of these states. Changes between the states are called phase changes.

Heat can be interpreted as a form of kinetic energy. Chemical bond energy is one of the forms of potential energy. Energy can change from one form to another.

Some pure substances cannot be decomposed into simpler substances. These are the elements. Some substances can be further decomposed. These are compounds. One cannot distinguish between elements and compounds on the basis of appearance alone.

OBJECTIVES

The student should (or should be able to):

1. List and describe the states of matter. Give examples of substances in each of the states.

2. Give examples of changes in substances from one state to another. Discuss the associated energy changes.

*3. Compare elements, compounds and mixtures. (Ledbetter '73 p 37; Turner '74 p 38; Cotton '73 p 169; Atkinson '73 pp 17,26)

4. Give examples of changes in forms of energy.

5. Use the following words correctly: Mass, weight, volume, density, physical property, chemical property.

*6. Use chemistry and physics handbook. (Ledbetter '73 p 35)

*7. Observe and describe a variety of phase changes. (Carmichael '71 p 107; Ledbetter '73 p 41; Cotton '73 p 7)

*8. Use various techniques to separate the components of a mixture. (Ferguson '70 pp 30,31; Bickel '73 pp 1,13; Bolton '73 pp 1/60, 2/10,7/13; Toon '73 pp 17,28; Jarvis '73 p 93)

*9. Perform several introductory chemical experiments. (Gordon '73 pp 30,51,64,70,96; Bickel '70 pp 22,29; Ledbetter '73 p 23; Atkinson '73 pp 14,31)

In certain contexts throughout this guide,"weight," in quotes, is used interchangeably with "mass."

UNIT II - STUDENT ABILITIES, INTERESTS, NEEDS, AND VALUES

CAREER CONCEPTS

7. Individuals have different abilities, interests, needs, and values.
14. Individuals may be suited for several different careers.

OBJECTIVE

Each student, through self-evaluation, will obtain a knowledge of his abilities, interests, personality traits, achievement, aptitudes, and needs.

ACTIVITIES

Arrangements should be made with Guidance for students to fill out the VITAL self-evaluation forms. Ask a Counselor to discuss these forms and follow up with individualized interpretations later if needed. The forms can be filed for future reference and comparison with specific career requirements.

Arrange with Guidance for students to take self-evaluation tests on science careers if they are available.

Have the Counselor explain to the students how to go about obtaining the results of tests previously taken by them.

Arrange for individual conferences with Guidance for any students who need it.

CAREER-ENTRY SKILLS ACQUIRED IN THE CAREER ACTIVITIES AND THE CURRICULUM ACTIVITIES

Ability to carry out an objective evaluation.
Use handbook, describe, classify, communicate, calculate
Separate, filter, chromatography techniques

RESOURCES

VITAL Self-Evaluation, Forms 2A, 2B, 2C, 3, 4 - Vital Career Information Center

Test Yourself for Science - Scientific Manpower Commission ($1.00)

III MEASUREMENT

CONTENT AND INTENT

Chemistry is an experimental science in that all we know about chemistry is based solidly on experiment. Accuracy in measurement and calculation is the backbone of experiment.

A quantity expressing a measurement should show units and should also include information about how precisely the measurement was made. Precision is usually expressed in terms of uncertainty, or less rigorously, by significant digits. Proper handling of significant digits should be required in all measurements and calculations.

The overall error in a result includes the effect of the systematic errors (which bias the experiment) as well as the effects of uncertainties (due to the limitations of the measuring instruments). One should strive to make measurements as precisely as possible, but should accept that absolute precision is not ever possible.

Many quantities are more appropriately expressed by use of scientific notation. Such expressions are easier to use in calculations, and they remove all doubt as to the number of significant digits being claimed.

Unit analysis in problem solving should be rigorously adhered to throughout this course.

OBJECTIVES

The student should (or should be able to):

*1. Develop entry-level skills in manipulating laboratory equipment, handling chemicals, making measurements, estimating metric quantities and expressing measured and derived quantities. Properly indicate units and precision. (Cotton '73 pp 34,42,63, 79,90; Bolton '73 pp 1/22,1/30; Ferguson '70 pp 11,15,23; Turner '74 pp 12,14,23,111; Carmichael '71 p 13; Ledbetter '73 pp 5,20,23,27; Toon '73 p 21; Bickel '73 pp 18,19; Davis '68 pp 3,6; Atkinson '73 p 20)

2. Demonstrate how uncertainties in measurement carry over into calculated results.

3. Calculate per cent error in a result.

4. Discuss differences in systematic errors (bias) and random errors (uncertainties) as to their origin and their effect on calculated results.

5. Use most frequently encountered prefixes in the metric system.

*The teacher should make suitable adjustments in mathematical requirements, particularly as they relate to uncertainties and scientific notation. One should insist upon "entry-level" proficiency in significant digits and in unit analysis. Significant digit rules can be rationalized as outlined in Appendix II rather than more rigorously from uncertainties. Arithmetic calculations with scientific notation can well be left until later in the course when the student is, hopefully, more secure.

UNIT III - SCIENCE RELATED CAREERS

CAREER CONCEPTS

10. Careers can be grouped into clusters
11. Different careers are interrelated
18. Careers have different levels of competence and responsibility

OBJECTIVE

Students become informed on the kinds and variety of science-related careers and the training required.

ACTIVITIES

Ask students to begin keeping a notebook on Career Exploration.

As a class activity ask the students to list all the science-related careers they can think of. Supplement their lists with suggestions from resources listed on the right.

Have students classify the careers in groups of related careers (such as medical, chemical).

Ask a few students to compile a master list to put on a bulletin board reserved for Career Exploration.

Ask students to classify these careers according to the estimated training required.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Compile a list of related ideas
Classify things in different ways
Measure, make value judgements, calculate

RESOURCES

"Careers Related to Science" - V.I.E.W. - Vital Career Information Center. See Appendix V

"Science-Related Careers" - See list in Appendix IV

"Jobs in Science" - ($1.50) Science Research Associates

"Selected Sources of Information on Careers in Science" - Office of Education and Training, Smithsonian Institution

"Sources of Career Information in Scientific Fields" - Manufacturing Chemists Assn.

"Keys to Careers in Science and Technology" ($1.00) - National Science Teachers Assn.

SEARCH (Science Engineering and Related Career Hints) - Scientific Manpower Commission

IV ATOMIC THEORY - MOLECULES AND THE MOLE

CONTENT AND INTENT

Although much of the evidence that supports the atomic theory is beyond the comprehension of the student at this time, some early reference to "what" we believe about atoms seems to be indicated. The student will need to be assured that we will return later to a more in-depth consideration of "why" we believe in atoms.

The concepts of atoms, molecules, molar volume, the mole, atomic "weights" (mass) and avogadros number evolved out of a long history of scientific investigations and thought. It is still evolving.

The initial difficulty that some students have with calculations related to the mole does not necessarily indicate that they will be unable to handle the mole concept. It means that they need more time and much more practice. The mole concept is central to the development of skill in chemical calculations.

Appendix III describes a guide that can be used as a "temporary" crutch. This will give the student security that he so desperately needs early in the course. The student should be expected to abandon the "crutch" within a few weeks.

OBJECTIVES

The student should (or should be able to):

1. Read atomic "weights" (mass) from periodic table and use them to calculate molecular and formula weights.

2. Interchangeably express amounts of a substance as grams, atoms, moles, and P.V. product at 0°C or 25°C. (These are temperatures for which P.V. product is quoted in most texts)

*3. "Weigh" several elements and compounds. Express the amount as number of moles. (Turner '74 p 42)

*4. Experience a number of chemical reactions in the laboratory. Describe reactants, products, and evidences of energy involved. (Carmichael '71 p 45; Bolton '73 pp 1/6,1/10)

*5. Explore one or more chemical reactions in depth. Determine, by measurement, the number of moles of substances involved. (Tellifsen '70 pp 18,23; Ferguson '70 pp 57,61,65)

6. Use combining volume, combining "weight", and/or multiple proportion data to rationalize the existence of molecules and atoms. (Cotton '73 p 130)

*7. Compare "weights" of equal volumes of gases. (Toon '73 p 34; Cotton '73 p 119; Davis '68 p 8)

*8. Determine approximate molecular size. (Ferguson '70 p 53; DeVoe '73 p 17; Toon '73 pp 37,42)

UNIT IV - WOMEN AND SCIENCE CAREERS

CAREER CONCEPTS

3. Meaningful, rewarding careers are available to every individual
8. Individuals seek careers for varied reasons
15. Individuals adapt to world changes and environment

OBJECTIVE

To explore the widening of career opportunities to women and inform students on new careers open to women.

ACTIVITIES

Arrange for interested girls to visit and talk to women in professional careers, such as medicine, research, etc. A list of topics to discuss should be prepared ahead of time for the visit.

Arrange for a woman in a technology field, such as medical or radiologic, to come to school and talk to the class.

Ask one or two girls to write technical organizations for women in science for additional information.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Evaluate employment trends
Assess career opportunities
Build and evaluate models, use and interpret tables, graphs

RESOURCES

Nontraditional Careers for Women 1973 ($4.79)
Julian Messner

"Wanted: More Women Engineers in Agricultural Engineering" (5 cents)
"Women in Engineering Professions" (5 cents) -
American Society of Agricultural Engineers

"Women in Engineering" - Engineers Joint Council ($1.50)

"Medicine: Are You Woman Enough to Try?" -
Student American Medical Assn, Women in Medicine

Organizations for women in science:

American Assn. for the Advancement of Science
Ms. Virginia Walbot, Dept. of Biochemistry
University of Georgia, Athens, Ga. 30601

Assn. of Women in Science; Dr. Neena B. Schwartz
Dept. of Psychiatry, College of Medicine
University of Illinois, Medical Center
P. O. Box 6998, Chicago, Ill. 60680

V THE LANGUAGE OF CHEMISTRY AND PRINCIPLES OF CHEMICAL REACTIONS

CONTENT AND INTENT

The shorthand notation of chemistry - symbols, formulas, and equations - is a basic and vital part of chemistry.

The balanced chemical equation is the key to quantitative relationships in chemical reactions because it expresses the mole ratios among substances involved.

Mass is conserved in chemical reactions. The integrity of the atom is maintained.

Compounds are composed of configurations of atoms held more or less rigidly in place by attractive forces. Chemical bonds result from these attractive forces. Chemical reactions proceed by the breaking of bonds between atoms and the subsequent rearrangement of the atoms into new configurations held together by new bonds.

Chemical changes are characterized by the formation of new substances. There is wide variation in the rates of chemical reactions. They are always accompanied by energy changes.

OBJECTIVES

The student should (or should be able to):

*1. Investigate several chemical reactions in the laboratory. With the help of the teacher, write balanced equations for the reactions. (Toon '73 pp 56,67,74; Carmichael '71 pp 151,159; Tellifsen '70 p 28; Bolton '73 pp 1/50,1/54,5/26,5/28; Cotton '73 pp 151,197)

*2. Use "weight" data to determine mole ratios and/or empirical formulas for compounds. (Atkinson '73 pp 45,50; Davis '68 pp 13, 17,21,126; Carmichael '71 pp 35,45,51,59; Ferguson '70 pp 61,93; Toon '73 pp 46,56,58,67,71,74; Bickel '71 pp 41,45,47; Turner '74 p 73; Tellifsen '70 pp 106,107;Cotton '73 pp 173,568)

3. Interpret chemical equations in terms of molecules and in terms of moles.

*4. Use boiling point and freezing point data to determine molecular "weight." (Carmichael '71 p 177; Bickel '71 p 54; Toon '73 p 171)

5. Develop entry-level proficiency in writing formulas.

6. Balance equations by conservation of atoms.

7. Do stochiometric problems for chemical reactions.

UNIT V - TENTATIVE CAREER SELECTIONS

CAREER CONCEPTS

12. Every career requires some special preparation and a plan of special preparation facilitates this.

OBJECTIVE

Each student will acquire a comprehensive look at his tentative career selection by making a systematic investigation and obtaining facts about it.

ACTIVITIES

Ask each student to make a tentative choice of a science related career.

Each student will make a survey of his choice, using all possible resources, and plan a culminating report which will summarize his findings.

Ask students to keep a list of all curriculum studies which are relative to his career selection and incorporate these in his final report.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Collecting information and organizing it
Preparing reports
Decision making
Communicate, write reports, calculate
Decant, separate, filter

RESOURCES

VITAL Reader-Printer (located in Guidance for obtaining up-to-date occupational information)

Sources of information listed in Appendix IV, Science Related Careers

Pamphlets listed in succeeding units on specific careers and in Unit III

Local industries

Louisiana institutions of higher learning can supply material on science careers offered.

VI RADIOACTIVITY AND NUCLEAR CHANGE

CONTENT AND INTENT

We think of atoms as being composed of a nucleus surrounded by electrons which are held within a poorly defined boundry by electrical forces. Chemical reactions involve the electrons. Nuclear reactions involve the nucleus.

Symbols written to represent nucleons give no information about the electrons, the compounds of which the nuclei are a part, or the chemical bonding involved, since these have no effect on nuclear reactions.

Spontaneous nuclear reactions occur by a process of radioactive decay. The course of these reactions is outlined in radioactive decay series charts.

Non-spontaneous nuclear reactions can be initiated by neutron bombardment or bombardment with mechanically accellerated particles.

Investigations with radioactivity led to the discovery of isotopes. The existence of isotopes can be demonstrated by mass spectrography.

The knowledge and technology we now possess signals a new era in radioisotope use and nuclear energy production.

OBJECTIVES

The student should (or should be able to):

*1. Investigate some principles of radioactivity. (Turner '74 p 154; Ferguson '70 pp 221,225; Toon '71 p 277; Tellifsen '70 pp 118,119, 123; Viola '73 pp 17,28,41,64,75)

2. Use symbols to describe nuclear reactions and to distinguish between isotopes.

3. Describe some nuclear particle accelerators.

4. Become familiar with some radioactive decay series.

5. Write equations for nuclear reactions.

6. Draw and interpret radioactive decay curves.

7. Discuss some of the landmark discoveries and experiments in radioactivity.

8. Discuss some of the hazards associated with, and safeguards practiced in the construction and operation of nuclear power plants.

9. Discuss harmful and beneficial effects of radioactivity.

10. Describe the operation of the mass spectrometer.

*11. Become familiar with local civil defense operations as they apply to radiation monitoring.

High School Training Kits are on loan from Louisiana Civil Defense Agency, Radiological Instrument Maintenance Shop, Post Office Box 44007, Capitol Station, Baton Rouge, Louisiana 70804. Phone 504-342-6861 Ext. 305. (Ask for High School Training Kit CDV-755)

UNIT VI - CAREERS IN TECHNOLOGY

CAREER CONCEPTS

7. Individuals have different abilities, interests, needs and values
17. Careers require different levels of competence in communication, computation, and analysis

OBJECTIVE

Students will acquire a knowledge of opportunities in scientific fields which require less training than a college degree.

ACTIVITIES

Arrange for a representative from a technology school to talk to the class or to interested students.

Make plans for small groups of students (two or three) to visit some local industries and talk to technicians who are employed there. Tape the interviews, if possible.

As a class activity have the students make a list of questions to be used when interviewing resource people as in the above activity.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Utilization of resource people
Evaluate data, interpret, build models and evaluate
Use references, graphs

RESOURCES

"Biomedical Equipment Technician" - Technical Education Research Centers

"A Career in Laboratory Animal Science and Technology" - American Assn. for Laboratory Animal Science

"Seven Steps to a Career in Space Science and Technology" - National Aeronautics and Space Administration

"The Electronics Service Technician" - Electronic Industries Assn.

"The Engineering Technician" - American Society for Engineering Education (50 cents)

"The Ocean and You" - Marine Technology Society

"Food Science and Technology - A Career for You?" The Institute of Food Technologists

"The Psychiatric Technician" - National Assn. of Human Services Technologists

"The Metallurgical Engineering Technician" - American Society for Metals

"Nuclear Medicine Technician/Technologist" - Technical Education Research Centers

"Federal Careers for Technicians in Engineering and Physical Science" - U. S. Civil Service Commission

NOTE: Medical Technologists - See Unit XVI
Chemical Technician - See Unit VII

VII THE GAS PHASE

CONTENT AND INTENT

Much of our early productive thinking in chemistry came from investigations with gaseous phases of substances. Boyle's Law and Charles' Law were instrumental in the development of the kinetic theory of gases and the ideal gas law, PV=NRT.

Avogadros interpretation of the combining volume ratios for gases provided an experimental method to measure the molar mass of a gas. This was the breakthrough we needed to permit the determination of molecular formulas and the measurement of atomic weights.

In a mixture of gases, the total pressure is the sum of the partial pressures of the components. The partial pressures are in the same ratio as the number of moles.

The rate of diffusion of a gas is dependent on the average velocity of its molecules. The velocity is a function of molecular weight and temperature.

In an equilibrium liquid phase - gaseous phase system - the vapor pressure is constant for a constant temperature. Such a system responds to changes in volume through a mechanism of a reversible reaction between gaseous and liquid phase. This maintains a constant vapor pressure for a constant temperature.

OBJECTIVES

The student should (or should be able to):

*1. Investigate Boyle's Law. (DeVoe '73 p 24; Toon '73 p 77; Ferguson '70 p 39; Ledbetter '73 p 102; Turner '74 p 87)

*2. Investigate Charles' Law. (DeVoe '73 p 29; Carmichael '71 p 137; Toon '73 p 77; Davis '68 p 29)

3. Work Boyle's Law and Charles' Law problems.

4. Participate in derivation of PV=nRT from empirical data.

*5. Determine molar mass for a gas from laboratory measurements of volume, temperature, pressure, and "weight." (Toon '73 p 92; Ferguson '70 p 47; Bickel '71 pp 33,60; Davis '68 p 32)

6. Work problems associated with PV=nRT.

*7. Compare diffusion rates of gases (Ledbetter '73 p 100; Carmichael '71 p 145)

*8. Determine the ideal gas constant empirically. (Toon '73 p 48)

UNIT VII - CHEMICAL TECHNICIAN CAREER

CAREER CONCEPTS

7. Individuals have different abilities, interests, needs, and values
18. Careers have different levels of competence and responsibility

OBJECTIVE

Students will become informed on all the aspects of the relatively new career of chemical technician which requires less than a B.S. degree.

ACTIVITIES

Arrange for students interested in this career to visit an industry where chemical technicians are employed so they can see what kind of work they do. Students should take note of all the obvious skills required for the work.

Students can contact Junior Colleges or colleges that offer a two-year course in chemical technology for information.

Students can write several chemical or petroleum industries in the state and get information on their policies in regard to chemical technicians as there is variation. (In the past technicians have been obtained by promoting equipment operators or putting high school graduates through company training programs. The trend now is for employers to prefer the graduates of two-year chemical technology programs.)

CAREER-ENTRY SKILLS ACQUIRED FROM CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Observe and assess the usefulness of skills
Measure pressure, record, evaluate and interpret data

RESOURCES

"A Different Career in Chemistry" - American Chemical Society

"Is Chemical Technology the Career for You?" - American Chemical Society

"Probe Tomorrow as a Chemical Technician" - Manufacturing Chemists Association

"A Bright Future for You as a Chemical Technician" Manufacturing Chemists Assn.

Northwestern State University, Institute of Technology, at Natchitoches, Louisiana, offers a two-year course in Chemical Technology.

Mary Holmes College, West Point, Miss. 39773 is a pilot school in an American Chemical Society project for developing a Chemical Technicial curriculum.

VIII CONDENSED PHASES

CONTENT AND INTENT

Our models for condensed phases are not as satisfactory as our models for gases.

Whether a system is composed of a gas, liquid, solid, or a mixture of these, the total energy of the system is the sum of the kinetic and potential energy. In gases, much of the energy is kinetic. The integrity of the molecule is more or less maintained during phase changes.

The boiling temperature of a substance is the temperature at which the vapor pressure is equal to the ambient pressure. (1.0 atm. in an open container at sea level)

Molar heats associated with phase changes can be measured calorimetrically. They are lower than molar heats associated with chemical changes. Molar heats of vaporization correlate positively with boiling temperatures. This may be interpreted as a clue about intramolecular bonds in condensed phases.

OBJECTIVES

The student should (or should be able to):

*1. Use data collected in the laboratory to draw heating and cooling curves for pure substances. (Tellifsen '70 p 4; Cotton '73 p 10; Davis '68 p 38)

2. Interpret heating and cooling curves in the region of the phase change.

*3. Use calorimetric measurements made in the laboratory to calculate heat capacity of a substance. (Cotton '73 p 62; Ferguson '70 p 83)

*4. Use measurements made in the laboratory to calculate molar heats involved in a phase change. (DeVoe '73 p 66; Toon '73 pp 136,139; Carmichael '71 p 65; Davis '68 pp 42,43)

5. Use handbook data to correlate molar heats of vaporization with boiling points of pure substances.

6. Describe boiling on a molecular level.

*7. Compare allotropic forms of a substance (Turner '74 p 248; Carmichael '71 p 113)

*8. Compare properties of liquid, solid, and gaseous phases. (Bickel '71 p 19; Bolton '73 pp 1/37,1/43)

*9. Investigate properties of ionic solids. (Ledbetter '73 p 115; Carmichael '71 p 119)

UNIT VIII - CHEMISTRY CAREERS

CAREER CONCEPTS

18. Careers have different levels of competence and responsibility.

OBJECTIVE

Students will become informed on the variety of careers available for chemists and the training required.

ACTIVITIES

Have the students as a group prepare a list of chemistry careers (consider major fields of study and types of employment). See suggestions to the right.

Ask the students who are interested in a specific chemistry field (such as biochemistry) to write to universities for information on careers in these specific fields.

CAREER ENTRY-SKILLS ACQUIRED IN THE CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Ability to place information in categories.
Evaluate
Use handbook, calculate, graph, interpret graphical data
Measure, characterize

RESOURCES

"Career Opportunities in Chemistry" - American Chemical Society (Reprint from March, 1971, issue of "Chemistry")

"Careers in Chemistry: questions and answers" - American Chemical Society

"Careers in Biochemistry" - Educational Affairs Committee, American Society of Biological Chemists, Inc.

FACTS ABOUT CHEMISTS (NSF, 1972)

HIGHEST DEGREE
Ph.D. 34%; M.S. 22%; B.S. 42%

EMPLOYER	
Educational institution	23%
Industry and business	58
Federal Government	6
Other government	2
Nonprofit organization	2
Self-employed	1
Military	2
Other	6
PRIMARY WORK ACTIVITY	
Research and development	36%
Management	25
Teaching	12
Production and inspection	15
Other	12

Chemistry fields: Analytical, biochemistry, inorganic, organic, physical, polymer

Current demand is highest for biochemists, organic and analytical chemists

IX SOLUTIONS, SOLUBILITY AND IONS

CONTENT AND INTENT

The behavior of solutions during phase changes is different from the behavior of pure substances.

The solubilities of solutes in solvents vary widely. The properties of the resulting solutions also vary. The water solutions of electrolytes conduct an electric current. The water solutions of non-electrolytes do not.

Much of elementary chemistry is concerned with reactions in water solution.

It is thought that conduction through a solution is due to the presence of charged species (ions). Conduction alone does not prove the existence of ions. Rather, the assumption that ions exist provides a logical explanation for conduction. "Ions" also serve us well as explanations for many other properties of substances.

Arrhenius postulation of the ion as a vehicle of electrical conduction was not eagerly accepted by his contemporaries.

Ions are separate species, unlike the parent atoms from which they are formed. The behavior of an ion is independent of the source of the ion.

OBJECTIVES

The student should (or should be able to):

*1. Investigate conductivity of water solutions. (Toon '73 p 160; Carmichael '71 p 89; Ledbetter '73 p 57)

2. Work problems related to molar concentration of solutions.

*3. Compare heating and cooling curves for solutions with heating and cooling curves for pure substances. (Toon '73 p 139; Davis '68 p 44)

*4. Prepare solutions of designated molarity. (Bolton '73 p 4/53; Atkinson '73 p 73)

5. Write balanced ionic equations.

*6. Accumulate experience with many precipitation reactions. (Toon '73 p 63; Bolton '73 p 2/2; Ledbetter '73 p 118; Turner '74 p 344; Carmichael '71 p 171; Ferguson '70 p 191; Tellifsen '70 p 41; Davis '68 pp 46,50)

7. Describe the solution process on a molecular level.

*8. Do qualitative tests for anions and cations. (Ledbetter '73 pp 57, 67,71,73,122,126; Gordon '73 pp 61,118; Toon '73 pp 99,219; Carmichael '71 p 257; Tellifsen '70 pp 111,113; Bolton '73 p 4/11; Davis '68 pp 53,58,59)

*9. Investigate properties of colloidal states. (DeVoe '73 p 53)

*10. Compare solubilities. (Bickel '71 pp 38,39; Carmichael '71 p 165; Cotton '73 p 348; Bolton '73 p 2/28; Ledbetter '73 p 55; DeVoe '73 p 49; Davis '68 pp 52,55)

UNIT IX - EMPLOYMENT OUTLOOK FOR CHEMISTS

CAREER CONCEPTS

9. Environmental variability creates variable opportunity.

16. World changes, conditions and environment affect careers.

OBJECTIVE

Students will acquire an overall picture of chemistry careers which includes current facts and trends based on up-to-date data.

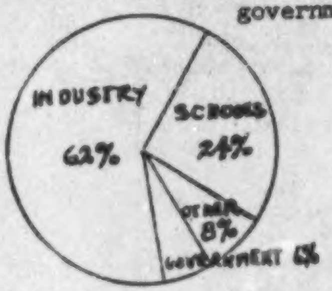
ACTIVITY

Obtain the most recent October issue of "Chemical and Engineering News" journal which will contain articles on "Employment Outlook" for chemists for the approaching year. Assign interested students to study these articles and report on them in class. (This series of articles covers employment trends, salary survey, supply/demand, etc.)

RESOURCES

"Employment Outlook '74" Chemical & Engineering News, October 8, 1973, page 9, or 50 cents each, Reprint Department, American Chemical Society Publications (this is an annual feature and can always be ordered for the forthcoming year).

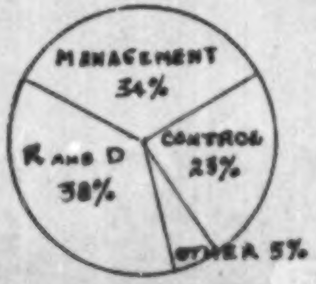
Most chemists work for industry, schools, and government



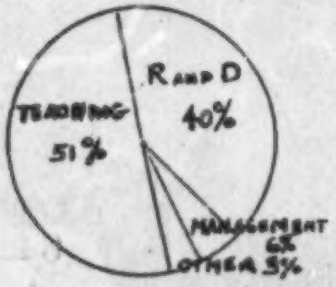
CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Interpret and evaluate data and trends.
Analyze samples, measure, filter, decant, precipitate.

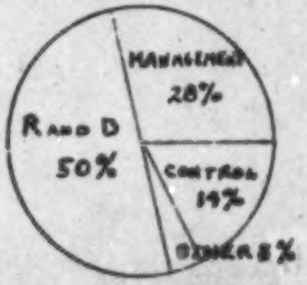
Of those in industry, most are in R&D and management . . .



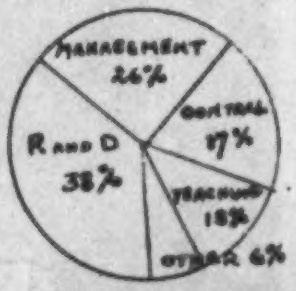
. . . in schools, half are in teaching.



. . . in Federal Government most are in R&D . . .



. . .and of all chemists, biggest group is in R&D



X THE PERIODIC LAW - ORDER AMONG ATOMS

CONTENT AND INTENT

Several less than fruitful attempts had been made to find some regularity in the properties of the elements when Mendeleev (1870) succeeded with a scheme which revealed periodic properties of the elements when they were arranged roughly by increasing atomic weights. The recognition that properties of elements are periodic functions of their atomic numbers is one of man's most creative scientific achievements.

The periodicity is conveniently displayed by arranging the elements in a periodic table. This facilitates the learning of a great deal of chemistry of many elements by studying in depth the chemistry of one representative member of each family. We can deduce much about the chemistry of an element from its position on the periodic table.

The question of why there exists this beautiful periodicity in properties of the elements requires to be asked. It will be found later in atomic structure.

OBJECTIVES

The student should (or should be able to):

*1. Summarize the extent to which Mendeleev's prediction of properties of elements undiscovered at his time coincides with their real measured properties. (O'Connor text '68 p 102)

2. Deduce properties of elements from their positions on the periodic table.

3. Describe some important trends in properties within some of the families of elements.

4. Use known reactions of one member of a family of elements to predict reactions for another member of the same family.

5. Discuss differences and trends in properties of elements across a horizontal row on the periodic table.

*6. Investigate and graph some trends in periodic functions using handbook data. (Ledbetter '73 p 75; Bolton '73 p 5/18)

*7. Summarize the organization of some standard periodic table. (Bolton '73 p 4/6; Toon '73 p 110)

*8. Investigate Periodicity of Physical, Chemical and Atomic properties. (Toon '73 p 110, Huheey '73 pp 24,33)

UNIT X - CHEMISTRY RELATED CAREERS

CAREER CONCEPTS

11. Different careers are interrelated
13. Individual careers may change as individuals change throughout life
14. Individuals may be suited for several different careers

OBJECTIVE

Students will learn that many careers require a relatively thorough knowledge of chemistry.

ACTIVITIES

As a class activity ask the students to list careers that are chemistry related. Put the list on the Career Exploration bulletin board.

Ask the students to list local industries that are chemical or chemistry related.

Have a student write to Louisiana Department of Commerce and Industry for a list of industries in Louisiana and from this select the ones that are chemical in nature.

Begin asking some of the students who have completed reports on their career selections to make oral reports to the class.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Recognize interrelations
Build models, describe, communicate
Use tables, follow trends, classify,predict, test predictions

RESOURCES

Louisiana Department of Commerce and Industry

A list of some careers closely allied to chemistry is given below. It is not intended to be a complete list.

Atomic Energy
Biological Science
Engineering, especially Chemical and Petroleum
Dentistry
Medicine
Medical Technology
Radiologic Technology
Health and Medicine
Dietetics and Nutrition
Environment and Ecology
Pharmacy
Veterinary Medicine

NOTE: Some of these are in units which follow. Several are considered in groups or clusters

XI MORE ABOUT THE STRUCTURE OF ATOMS

CONTENT AND INTENT

The atomic theory is a scientific model, invented by man to aid in his attempt to explain the nature and behavior of matter. The theory has a distinguished history, having undergone many revisions as it evolved into its present form.

Atomic models progressed from the Dalton model, through the Thomson, Rutherford, Bohr, and quantum mechanical model as experimental evidence accumulated from such sources as the Thomson e/m experiment, Rutherford Scattering experiment, and the analysis of the hydrogen spectra.

Our present model of the atom places the electrons in orbitals around the nucleus. Orbitals are solutions to the Schrodinger wave equation which describes atoms in terms of wave properties.

Knowledge of orbitals and electron population permits us to correlate and explain a large body of empirical information about chemical properties of elements.

OBJECTIVES

The student should (or should be able to):

*1. Investigate cathode rays. (Turner '74 p 151)

2. Describe the following experiments and tell how each influenced the development of atomic theory: Thomson e/m, Rutherford Scattering, Michelson oil drop, and discovery of neutron.

3. Discuss the Bohr interpretation of the Rutherford Scattering experiment.

4. Describe the following models of the atom: Dalton, Thomson, Rutherford, Bohr, and quantum mechanical model.

5. Show how energy levels were deduced from the spectra of the hydrogen atom.

6. Write electron configurations for atomic species.

*7. Correlate electron configurations with the periodic table. (Ledbetter '73 p 73)

*8. Review flame tests. Investigate spectra from gas discharge tubes. (Ferguson '70 p 113; Turner '74 p 197; Toon '73 p 103)

UNIT XI - ATOMIC ENERGY CAREERS

CAREER CONCEPTS

15. Individuals adapt to world changes and environment
16. World changes, conditions, and environment affect careers

OBJECTIVE

Students will become familiar with the many opportunities in the Atomic Energy field.

ACTIVITIES

Ask students to check on the number of local industries and medical centers which make use of nuclear energy.

Arrange for someone from a nuclear energy center or medical center to talk on the use of nuclear energy in the medical field. A Radiotherapist would be best if one is available.

Arrange for some of the students to visit a Nuclear Science Center at the nearest University.

Arrange for someone from a local utility company to discuss with the class the use of nuclear energy in power plants and the careers related to this.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Use of resource people
Build, evaluate and test models
Use graphs, calculate

RESOURCES

"Employment Opportunities in the Atomic Energy Field" - Bureau of Labor Statistics, U. S. Dept. of Labor (Order from Government Printing Office - 50 cents)

"Health Physics: A New Profession in the Atomic Age" - Health Physics Society

"Should You be a Nuclear Medical Technologist?" Society of Nuclear Medical Technologists

XII DETERMINATION OF MOLECULAR STRUCTURE

CONTENT AND INTENT

Chemical analysis of compounds provides the information needed to write empirical formulas. Determination of molar mass, then, leads to molecular formulas.

Clues about structural arrangement of the atoms come from such sources as X-ray diffraction, infra-red spectrometry, nuclear magnetic resonance and measurements of dielectric constants.

A large number of structures for molecules have been described and generally accepted. We have been able to correlate many chemical and physical properties with particular aspects of these structures.

Structures for molecules in question are proposed on the basis of dependable and accepted bonding principles. The proposed structures can be tested against our known standards.

This process, hopefully, leads to an accepted structure for the compound of molecule in question.

Some of the students will understand very little about the instrumentation discussed here. This entire topic can be deleted without severly jeopardizing the student's progress. It is included because it helps to answer the question that the students invariably ask, "How do they know the structure of the molecule?"

OBJECTIVES

The student should (or should be able to):

*1. Relate some chemical and physical properties of substances to aspects of their accepted molecular structures. (Tellifsen '70 p 82; Toon '73 pp 117,122,126)

2. Distinguish between empirical, molecular, and structural formula. Tell what kind of information is needed for determination of each.

3. Describe the following procedures and tell what structural clues are provided by each: X-ray diffraction, Nuclear Magnetic resonance, Infra-red spectrometry.

*4. Review determination of empirical and molecular formulas. (Ledbetter '73 p 110)

*5. Determine possible packing arrangements for metallic ions. (Ferguson '70 p 195)

*6. Do separations by chromatography. (Ferguson '70 p 201)

UNIT XII - CAREERS IN BIOLOGICAL SCIENCES

CAREER CONCEPTS

10. Careers can be grouped into clusters
11. Different careers are interrelated

OBJECTIVE

Students will learn about careers in biological sciences and the relation of chemistry to them.

ACTIVITIES

Ask a biology teacher to talk to the class about careers in biological sciences, especially those involving a broad knowledge of chemistry.

Arrange for interested students to visit a microbiologist at an industry producing food products or at a public health department to obtain career information.

Students can write for bulletins from universities on careers in various biological sciences.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Observe skills used in career work
Research a topic, deduce, synthesize, organize.

RESOURCES

"Careers in Biology" - American Institute of Biological Sciences, Education Division

"A Guide to Opportunities in Cell Biology" - The American Society for Cell Biology (30 cents)

"Microbiologist, Title #135 (35 cents) - Chronicle Guidance Publications

"Biochemist, #8-101 (35 cents) - Careers

XIII CHEMICAL BONDING

CONTENT AND INTENT

When electrons are simultaneously attracted to two nuclei, a state of lower potential energy is achieved and a chemical bond forms. This is the one and only real reason for the formation of any chemical bond.

Electron configurations provide a way to explain the chemical bond on the basis of availability of bonding orbitals. A covalent bond results from the sharing of a pair of electrons by the bonded atoms.

An electric dipole results from the assymatric distribution of the electrons between the bonded atoms. The overall polarity of the molecules is the vector sum of the electric dipoles in each of the component bonds.

Information about the magnitude of the electric dipole (the extent of ionic character) in bonds is tabulated in electronegativity scales.

Representations of bonding in molecules is simplified by the use of electron dot representations and structural formulas.

Additional forces that do not require the pairing of electrons come into play as substances condense. Among these intermolecular forces are Van der Waals, hydrogen bonding, dipole-dipole attractions and metallic bonds.

OBJECTIVES

The student should (or should be able to):

1. Use electron configurations to determine number of bonds, bond angles and geometry of molecules.

2. Discuss origin of polarity in molecules.

3. Diagram molecular bonding by using orbital representations, electron dot formulas,and structural formulas.

*4. Contrast network, molecular, ionic and metallic solids. Rationalize their properties on the basis of the intermolecular bonding types. (Ledbetter '73 p 86; Cotton '73 p 382; Huheey '73 pp 40,51)

5. Describe the hydrogen bond. Discuss its effect on the properties of compounds.

*6. Run several reactions in the laboratory. With the help of the teacher, write equations for the reactions. Note the energy involved. Discuss the reactions in terms of bond breaking and bond formation. (Tellifsen '70 p 43; Davis '68 p 61; Huheey '73 p 59)

7. Discuss the effect of relative electronegativity of atoms on the character of bonds.

UNIT XIII - ENGINEERING PROFESSIONS

CAREER CONCEPTS

5. Occupations contribute to society's progress
6. Careers require different knowledge, abilities, attitudes, and talents

OBJECTIVE

Students will become informed on the many engineering fields and the opportunities in them, especially the chemical and petroleum since they are closely allied with chemistry.

ACTIVITIES

Have students conduct a job opportunity survey by following the classified ad sections of newspapers and technical journals which list openings for various kinds of engineers.

Arrange for students who are interested to attend one of the annual engineering expositions held by Engineering Departments in universities.

Have students arrange to interview engineers from as many fields as possible and tape the interviews if possible. These can be made available to other students.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITES AND CURRICULUM ACTIVITIES

Ability to survey a situation and draw conclusions
Synthesize, organize

RESOURCES

Guidance Dept. should have: Careers and Opportunities in Engineering, E. P. Dutton & Co.

"Chemical Engineer, Career Summary" #S-136 (20 cents) - Careers

"Petroleum Engineering, Career Summary" #S-210 (20 cents) - Careers

"Sources of Career Information on Engineering Technology" - Engineers' Council for Professional Development

XIV ENERGY EFFECTS IN CHEMICAL REACTIONS

CONTENT AND INTENT

The energy involved in chemical reactions is relatively less than that involved in nuclear reactions and relatively more than that involved in phase changes.

All molecules store energy. Energy is always required for the breaking of bonds and always released upon the formation of bonds. Chemical reactions consist of the breaking of some bonds and the formation of others. The energy of an overall reaction is the algebraic sum of the energies involved in all of the bond breaking and bond forming processes in the reaction.

Calorimetric measurements of the heat of reaction can be made in the laboratory. Key ones have been tabulated in Heat of Formation tables. By applying the principle of additivity of heats of reaction, we can use these tables to calculate the energy involved in many reactions.

A tendency toward minimum potential energy is coupled with a tendency toward maximum entropy to furnish the driving forces, ΔG of a reaction. ΔG measures the tendency of a chemical reaction to "go."

OBJECTIVES

The student should (or should be able to):

*1. Use calorimetric measurements made in the laboratory to calculate ΔH for a reaction. Write the equation for the reaction. (Toon '73 p 147; Bickel '71 pp 49,50,52; Turner '74 p 261; Bolton '73 pp 2/18,9/4; Cotton '73 p 592; Carmichael '71 p 75; Tellifsen '70 p 46; Ledbetter '73 p 88; Davis '68 pp 64, 66,68)

2. Recall the relative amounts of energy involved in phase changes, chemical changes, and nuclear changes. Write equations for each of these types showing the ΔH. Use handbook data.

3. Discuss the relationship between heats of reaction and the making and breaking of chemical bonds.

4. Use heats of formation table to calculate ΔH for reactions.

UNIT XIV - ENVIRONMENTAL CAREERS

CAREER CONCEPTS

2. Individuals have many kinds of careers
16. World changes, conditions and environment affect careers

OBJECTIVE

Students will learn how environmental studies require the services of scientists from a wide variety of fields.

Students will learn that environmental studies entail work in many areas, such as conservation, ecology, and pollution controls.

ACTIVITIES

Arrange for students to talk to scientists in local industries who work in pollution controls.

Arrange for a representative from an EPA office to talk to interested students about careers in this field.

Contact the local public health office for information on careers in air pollution controls.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Recognize the unification of various careers to achieve goals

Measure, record and interpret data, organize, predict

RESOURCES

"Working Toward a Better Environment — Some Career Choices" - U. S. Environmental Protection Agency

"Information on Careers and Job Opportunities in Water Pollution Control" - Water Pollution Control Federation

XV THE RATES OF CHEMICAL REACTIONS

CONTENT AND INTENT

Rate expressions describe how some characteristic property (appearance of products, disappearance of reactants, concentration, color, pH, pressure) of a reacting system varies with time. Reactions can be controlled by manipulating factors that control their rates.

The collision theory provides a simple and effective way to understand the role of temperature and concentration in determining rates. The theory relates rate of reaction to the probability of chemically effective collisions. This probability depends on the concentration and kinetic energy of reacting species.

Potential energy diagrams are used to chart energy changes as a reaction progresses.

Overall chemical equations do not give information about reaction mechanisms. The exact mechanism is known for only a few reactions. The action of a catalyst in some reactions is fairly well understood; in others, it is not.

Much interesting work related to catalysts and reaction mechanism is now going on in our research institutions. This is an exciting and important area of research.

OBJECTIVES

The student should(or should be able to):

1. Write rate expressions for chemical reactions.

2. Use the collision theory to explain the effect of temperature and concentration on the rate of chemical reaction.

*3. Discuss probable mechanisms for some chemical reactions. Defend the proposed mechanism on the basis of the collision theory. (Gordon '73 p 58; Cotton '73 p 660)

4. Draw, label, and interpret potential energy diagrams.

5. Discuss the action of catalysts in chemical reactions.

*6. Investigate several catalyzed reactions in the laboratory. (Tellifsen '70 p 108)

*7. Investigate, in depth, a chemical reaction whose rate can be measured. Determine the factors that control the rate. (DeVoe'73 p 74; Bickel '71 p 77; Toon '73 p 151; Carmichael '71 p 183; Ferguson '70 p 129; Tellifsen '70 p 48; Ledbetter '73 pp 90,91; Turner '74 p 279; Cotton '73 p 611; Davis '68 pp 69,129)

UNIT XV - CAREERS IN MEDICINE, DENTISTRY, VETERINARY MEDICINE

CAREER CONCEPTS

14. Individuals may be suited for several different careers

OBJECTIVES

Students will acquire a knowledge of various medical professions and fields for specialization

Students will understand the interrelation of chemistry and medicine.

ACTIVITIES

Arrange for a Doctor to discuss with interested students the training required for an M.D. degree and for specialization. He should discuss the requirements and possiblities for being accepted in medical schools and the alternatives open to the students who are not accepted.

Students interested in medical professions should work in hospitals or clinics in established programs for high school students in order to acquire experience.

Arrange for interested students to visit a Veterinary Clinic and talk to the Doctor about careers in this field and his work at the clinic. Part-time work would be good experience.

Ask students interested in dentistry to talk to their own dentists about careers in dentistry.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Evaluate interest and abilities
Interpret graphs, communicate

RESOURCES

"A Career in Medicine" ($1.00) - B'nai B'rith Career and Counseling Services

"Dentistry - A Changing Profession" - American Dental Assn.

"There's An Action Career Ahead When You Become a Trained Dental Assistant" - American Dental Assistants Assn.

"Career Facts about Today's Veterinarian" - American Veterinary Medical Assn.

XVI EQUILIBRIUM IN CHEMICAL REACTIONS

CONTENT AND INTENT

On a macroscopic level, equilibrium is characterized by absence of observable change in a closed system. On a molecular level, equilibrium is dynamic. It is a condition reached in a reversible reaction when the rate of the forward reaction is equal to the rate of the reverse reaction. Several separate and independent equilibria can, and usually are, simultaneously maintained in a chemical system.

The state of a system at equilibrium can be altered by manipulating concentrations and/or temperatures. LeChatelier's principle qualitatively describes the responses of an equilibrium chemical system to stress.

Quantitative expressions describing equilibrium systems can be determined emperically and can be derived from rate expressions.

A reaction cannot be run "at equilibrium" since, at equilibrium, the concentrations of all components of the system are constant - there is no increase in the amount of products.

Saturated solutions are equilibrium systems.

OBJECTIVES

The student should (or should be able to):

1. Recall and discuss equilibrium vapor pressure.

2. Recognize equilibrium systems.

3. Write equilibrium constant expressions. Use these expressions to calculate concentrations.

4. Use Ksp to predict formation of precipitates. Hint: Use trial ion products.

5. Relate saturation and supersaturation to equilibrium.

*6. Calculate equilibrium constant for a reaction from empirical data. (DeVoe '73 p 84; Carmichael '71 p 195; Ferguson '70 p 139; Tellifsen '70 p 51; Cotton '73 p 664; Davis '68 p 73)

*7. Calculate Ksp for a partially soluble salt from empirical data. (Tellifsen '70 p 56; Ferguson '70 p 149; Carmichael '71 p 195; Bickel '70 p 71; Cotton '73 p 673)

*8. Investigate LeChatelier's principle. (Ferguson '70 p 133; Toon '73 p 156; Carmichael '71 p 189; Tellifsen '70 p 58; Davis '68 p 76)

9. Describe the dynamics of equilibrium on the molecular level.

*10. Explain fractional crystallization in terms of Ksp. (Toon '73 pp 208,211)

*11. Focus attention on Kw in preparation for study of acids.

UNIT XVI - MEDICAL TECHNOLOGY, NURSING, AND HEALTH CAREERS

CAREER CONCEPTS

3. Meaningful, rewarding careers are available to every individual
20. Careers are affected by the ability of individuals to relate to each other

OBJECTIVE

Students interested in medical fields will learn of the wide variety of careers available to them.

ACTIVITIES

Arrange for a Pathologist to talk to students who are interested in medical laboratory careers. Ask him to discuss Medical Technologist, Medical Laboratory Technician, Certified Laboratory Assistant, Cytotechnologist, and Histologic Technician, and the training involved in each.

Students interested in nursing should volunteer to work in hospitals in this area.

Students interested in health careers should visit the local public health center to see what services are offered there and what training is required for them.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Evaluate careers and training
Organize data, interpret

RESOURCES

"Careers in the M[illegible]ical Laboratory" - Registry of Medical Techn[illegible]gists

"Do You Want to be a Nurse?" - National League for Nursing, Inc. (35 cents)

"College Education: Key to a Professional Career in Nursing" - National League for Nursing, Inc. (40 cents)

"Careers in Health" - U. S. Dept. of Health, Education and Welfare

"Where to Get Health Career Information" - National Health Council, Inc.

"Educational Programs in the Health Field" - American Hospital Association

XVII ACIDS AND BASES

CONTENT AND INTENT

Acids are defined operationally in terms of properties of aqueous solutions. Bases neutralize acids.

Conceptually, Arrhenius defines acids as substances which produce H^+ and bases as substances which produce OH^-. Bronsted-Lowry defines acids as proton donors and bases as proton acceptors. We will focus our attention on these definitions since they relate to water solutions. (Most high school chemical reactions are in water solution.)

The Lewis conceptual definition is independent of the solvent water. Acids are electron pair acceptors and bases are electron pair donors in the Lewis definition.

In water solutions, $Kw=[H+][OH-] = 1x10^{-14}$. This equilibirum is maintained independent of any other equilibria that co-exist in a solution. The pH scale has as its basis the absolute value of the power of 10 of the hydrogen ion concentration, $[H+]$, in this expression.

Indicators are used to determine the pH of acid-base systems.

The strengths of acids are expressed in terms of their ionization constant.

OBJECTIVES

The student should (or should be able to):

*1. Use indicators to determine pH of common substances. (Toon '73 pp 168,188; Carmichael '71 p 20; Ferguson '70 p 157; Tellifsen '70 p 64; Cotton '73 p 700; Bolton '73 pp 2/22,3/10,3/16,3/22,3/24, 8/15; Davis '68 p 84; Huheey '73 p 72)

*2. Summarize properties of acids and bases. (Toon '73 p 50; Tellifsen '70 p 67; Bolton '73 pp 3/4,3/6)

*3. Standardize a solution and use it in a titration. (Bickel '71 pp 62,65,66,67,68; Turner '74 p 358; Cotton '73 p 711; Toon '73 p 184; Carmichael '71 p 217; Ferguson '70 p 163; Tellifsen '70 p 60; Davis '68 p 80)

4. Interpret acid-base behavior in terms of Arrhenius, Bronsted-Lowry, and Lewis definition.

*5. Compare ΔH's of acid-base reactions (Bickel '71 p 73; Davis '68 p 78)

*6. Investigate hydrolysis of salts. (Ledbetter '73 p 63; Carmichael '71 p 209; Bickel '71 p 56)

7. Translate among pH, $[H+]$ and $[OH-]$.

8. Correlate magnitude of Ka with strengths of acids.

9. Calculate pH of aqueous solutions of known concentrations of strong acids and soluble bases.

10. Investigate properties of buffered solutions - common ion effect. (Toon '73 p 182; Bickel '71 pp 56,69; Ledbetter '73 p 63; Carmichael '71 p 209)

UNIT XVII - PHARMACY CAREERS

CAREER CONCEPTS

8. Individuals seek careers for varied reasons
14. Individuals may be suited for several different careers

OBJECTIVE

Students will learn that pharmacists have many choices in careers.

ACTIVITIES

Arrange for a pharmacist who is in research for a drug company or at a medical center to talk to students interested in pharmacy.

Students interested in this career could make an appointment to talk to a pharmacist in a local drugstore about training and work.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Evaluating related opportunities
Measure, record data

RESOURCES

"Career Opportunities in Pharmacy" - American Assn. of Colleges of Pharmacy

"This Is the Profession of Pharmacology" - American Society for Pharmacology and Experimental Therapeutics, Inc.

XVIII OXIDATION AND REDUCTION

CONTENT AND INTENT

The operation of an electrochemical cell reveals the essential features of oxidation reduction reactions. Redox reactions can be thought of as the sum of two half reactions which can be isolated in an electrochemical cell.

The potentials for half reactions have been measured and are tabulated in standard oxidation potential tables. The E° for a redox reaction can be calculated from these. E° is an important factor in determining if a redox reaction will "go."

Half reactions must always occur in pairs. An electron releasing process must be paired with an electron gaining process.

Spontaneous electrochemical systems (dry cells, storage batteries, fuel cells) are important energy sources. They are likely to become even more important as our supply of fossil fuels diminishes.

Redox reactions do not necessarily involve complete clear cut electron loss or gain.

Oxidation numbers assigned on the basis of a set of arbitrary rules are helpful in balancing equations for redox reactions.

OBJECTIVES

The student should (or should be able to):

*1. Gain laboratory experience with redox reactions. (Toon '73 pp 225,229; Carmichael '71 pp 95,223,237; Tellifsen '70 pp 68, 73; Bolton '73 pp 3/2,5/10,5/13,9/25,9/27,9/28; Cotton '73 pp 562,727; Ferguson '70 p 103; Davis '68 pp 87,89,95)

*2. Measure electrochemical cell potentials. (Toon '73 p 237; Carmichael '71 p 243; Ferguson '70 p 177; Tellifsen '70 p 70)

3. Balance equations by half reaction method.

*4. Compare moles of electrons with moles of atoms involved in electrochemical reactions. (Toon '73 pp 95,241; Bickel '71 p 58; Ferguson '70 p 183; Tellifsen '70 p 36; Cotton '73 p 238; Davis '68 p 92)

5. Assign oxidation numbers and use them to balance equations for redox reactions.

6. Describe construction and operation of lead storage batteries, dry cells, and fuel cells.

*7. Do a redox titration. (Bickel '71 p 74; Toon '73 p 233; Carmichael '71 p 231; Ferguson '70 p 187)

UNIT XVIII - SCIENCE AND CHEMISTRY TEACHING CAREERS

CAREER CONCEPTS

19. Rules, regulations, policies, and procedures affect individuals in all careers
20. Careers are affected by the ability of individuals to relate to each other

OBJECTIVE

Students will learn about science and chemistry teaching careers in high school, universities, technology and vocational schools.

ACTIVITIES

Interested students can look at catalogs from universities and study the required courses of study for various science teaching fields.

Students can contact the State Education Department for information on teacher recruitment, preparation, certification and accreditation. Also, this information should be available in the school Resource Center.

Students can obtain copies of The Science Teacher published by the National Science Teachers Assn. and locate relevant material. (Copies should be available from local science teachers.)

Students interested in teaching science could arrange to help science teachers as laboratory assistants. If they are members of Future Teachers of America, they could assist teachers in ways approved by the organization and the school.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Evaluate interests and attitudes
Observe, characterize, compare, use data tables

RESOURCES

"Careers in Education" - National Education Assn. (50 cents)

"A Career for You as a Science Teacher" - National Science Teachers Assn. (25 cents)

XIX CARBON - THE CHAIN FORMER

CONTENT AND INTENT

The chemical principles governing the behavior of organic compounds are in no way unique. The classification of organic chemistry as a separate area of study is primarily one of convenience - the number of carbon compounds being so enormous.

Properties of organic molecules are very dependent upon the arrangement of the atoms in the molecule.

The carbon atom has outstanding ability to form four highly directed covalent bonds. Carbon can form single, double, and triple bonds.

The chemistry of carbon compounds is simplified by grouping hydrocarbons into series of related molecules, and by focusing attention on functional groups in the hydrocarbon derivatives.

Most organic reactions proceed slowly. Many require a catalyst.

Modern materials such as dacron, teflon, dyes, medicines, synthetic rubber, and plastics are synthesized from hydrocarbons. Our primary sources of raw materials for these synthetics are petroleum and coal.

OBJECTIVES

The student should (or should be able to):

1. Draw structural formulas for saturated and unsaturated hydrocarbons and their isomers.

*2. Examine and/or construct three dimensional models for organic molecules. (Turner '74 p 445)

*3. Run some organic reactions. (Bickel '71 pp 85,87,89; Toon '73 pp 265,268,271,273; Bolton '73 pp 6/22,6/24,6/30,7/4,7/7,7/18, 7/22,7/30,9/9,9/11,9/12,9/14,9/15,9/17,9/19,9/23; Tellifsen '70 pp 82,85; Carmichael '71 p 249; Ferguson '70 pp 211,213,215,217, 219; Cotton '73 pp 446,462,553; Davis '68 pp 100,104)

*4. Correlate some of the properties of organic compounds with their accepted structural formulas. (Tellifsen '70 pp 114,116)

5. Sketch structural formulas for derivatives of hydrocarbons.

6. Write equations for the following types of organic reactions: Combustion, addition, substitution, hydrogenation, dehydrogenation, cracking, addition polymerization, and condensation polymerization.

UNIT XIX - REPORTING ON TENTATIVE CAREER SELECTIONS

CAREER CONCEPTS

12. Every career requires some special preparation and a plan of special preparation facilitates this

OBJECTIVE

Students will prepare complete reports on their tentative career selections.

ACTIVITIES

Students should organize all the information they have obtained in regard to their career selections and write up a final report, including in it all the main ideas on the occupational study outline found in the Appendix.

Copies of these could be filed in the classroom for use in subsequent years if desired.

Copies of pamphlets obtained could be added to the material on a browsing table in the classroom.

Oral reports could be given in class as the students complete their work.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Summarizing information, drawing conclusions, making decisions, writing reports
Analyze, synthesize, predict

RESOURCES

"Occupational Study Outline" - Appendix VI

XX THE HALOGENS

CONTENT AND INTENT

The halogens show remarkable similarity to each other and also show well defined trends within the family.

The striking similarities among elements in this family were instrumental in the initial development of the periodic table. The trends within the family can be understood in terms of increasing nuclear charge, number of electrons, and nuclear size.

The halogens are so reactive that they do not occur uncombined in nature.

The principles governing the chemistry of halogens are the same as those we have previously studied.

OBJECTIVES

The student should (or should be able to):

1. Describe the electrolytic oxidation method for preparation of fluorine and/or chlorine. Write equations representing these reactions.

*2. Accumulate experience with reactions involving halogens. (Ferguson '70 p 99; Tellifsen '70 pp 73,88; Davis '68 pp 107, 109)

3. Discuss uses of halogens and halogen compounds.

4. Correlate chemical properties of halogens with electron configurations of their atoms.

5. Summarize trends within the halogen family.

*6. Prepare bromine and iodine by oxidation with chlorine. Write equations and discuss these reactions in terms of oxidation reduction.

UNIT XX - COMMUNICATING INFORMATION TO OTHERS

CAREER CONCEPTS

7. Individuals have different abilities, interests, needs and values
20. Careers are affected by the ability of individuals to relate to each other

OBJECTIVE

Students will pass on some of the career information they have obtained to other students not engaged in this program - to any interested students in the high school.

ACTIVITIES

Students should get permission from the Principal to set up tables in a main area of the school during some time of day when students would be free to look over materials on display. Reports and pamphlets on different careers could be displayed and students could be present to answer any questions.

Students could put on a Science Career program to be held in the evening. Resource people whom the students have contacted could be asked to help with this. These people could be located in separate rooms and the students allowed to circulate and talk to them. Another way would be to ask several resource people to give short talks to all the students attending. Students from other high schools could be invited to participate.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Organizing, communicating information to other people

Analyze, synthesize, classify

RESOURCES

Information collected during the career study in the form of pamphlets, books, etc.

Reports written at the end of the studies.

XXI THE FOURTH ROW TRANSITION ELEMENTS

CONTENT AND INTENT

The trends in properties of the fourth row transition elements can be explained in terms of changes in electron structure and nuclear charge as we move across the row.

There are no new principles involved in the chemistry of these elements except that the chemistry is influenced to some extent by electrons in d type orbitals.

Some transition elements form interesting complex ions. The way in which atoms and molecules are arranged around the central atom bears heavily on the properties of these complex ions. The coordination number determines the geometry of the species.

Complex ions are important in many of the chemical reactions that occur in living systems. Chlorophyll and hemoglobin contain complex ions.

Trace elements are made available to plants in fertilizers by chelating - a form of complexing.

OBJECTIVES

The student should (or should be able to):

1. Review electron configurations of fourth row transition elements.

2. Chart trends in properties of fourth row transitions.

*3. Accumulate experience with properties and reactions of fourth row transitions. (Ferguson '70 pp 205,207,209; Tellifsen '70 pp 93,95,97,99; Davis '68 pp 114,116,118; Huheey '73 pp 82,91,95)

4. Write structural formulas for complex ions. Correlate shapes of ions with electron configurations.

5. Describe some representative compounds of the fourth row transitions.

6. Outline the steps in the production of some of the fourth row transition elements for their ores.

*7. Do separations with ion exchange resins. (Ferguson '70 p 167; Tellifsen '70 p 90; Davis '68 p 111)

*8. Do separations by chromotography. (Ledbetter '73 p 71; Ferguson '70 p 201)

UNIT XXI - STUDENT EVALUATION OF CAREER EXPLORATION AND ACQUISITION OF CAREER-ENTRY SKILLS

CAREER CONCEPTS

12. Every career requires some special preparation and a plan of special preparation facilitates this.

OBJECTIVE

Students will evaluate this entire program of career exploration and acquisition of career-entry skills and make recommendations for additions or changes. The evaluation will enable the teachers to adapt this plan to meet the needs of the students in different schools and localities.

ACTIVITIES

Students will prepare a list of points that each student should consider in his evaluation of the program and how effective it has been in regard to his own career plans.

Each student will then prepare a written evaluation covering career exploration, career decisions, acquisition of career-entry skills from the curriculum activities and the career activities.

Ask two or three students to study these and summarize the recommendations. The students should present this to the class for group study and discussion.

A final summary of the evaluations and the changes to be incorporated into the program can be prepared by the students or teacher.

CAREER-ENTRY SKILLS ACQUIRED IN CAREER ACTIVITIES AND CURRICULUM ACTIVITIES

Evaluate a program, prepare reports, summarize reports
Compile information, classify, predict, test predictions

RESOURCES

Student reports on tentative career decisions.

APPENDIX I-A

CHEMISTRY TEXTBOOKS ADOPTED FOR USE IN LOUISIANA SCHOOLS - 1973

TEXTBOOK

Bickel, et al. Chemistry, Patterns and Properties, 1971; American Book Company, 55 Fifth Avenue, New York, New York 10003

LABORATORY MANUAL TO ACCOMPANY CHEMISTRY, PATTERNS AND PROPERTIES

Bickel, et al. Chemistry, A Laboratory Approach.

* * * * *

TEXTBOOK

Bolton, et al. Action Chemistry, 1973; Holt, Rinehart and Winston, Inc., 383 Madison Avenue, New York, New York 10017

LABORATORY MANUAL TO ACCOMPANY ACTION CHEMISTRY

Bolton, et al. Chemistry, A Laboratory Approach.

* * * * *

TEXTBOOK

Choppin, et al. Chemistry, 1973; Silver Burdett, Division of General Learning Corporation, Morristown, New Jersey 07960

LABORATORY GUIDE TO ACCOMPANY CHEMISTRY

Ferguson, et al. Laboratory Investigations in Chemistry.

TEXTBOOK (Laboratory guide combination)

Cotton, et al. Chemistry: An Investigative Approach, 1973; Houghton Mifflin Company, Educational Division, 110 Tremont Street, Boston, Massachusetts 02107.

(A LEARNING SUPPLEMENT IS AVAILABLE)

* * * * *

SET OF SEVEN MODULES (Each containing text and laboratory manuals)

Gardner, et al. Interdisciplinary Approaches to Chemistry, 1973; Harper and Row, Publishers, 49 East 33rd Street, New York, New York 10016.

The modules are:

Reactions and Reasons (An Introductory Chemistry Module)
Diversity and Periodicity (An Inorganic Chemistry Module)
Forms and Function (An Organic Chemistry Module)
Molecules and Living Systems (A Biochemistry Module)
The Heart of the Matter (A Nuclear Chemistry Module)
The Delicate Balance (An Environmental Chemistry Module)
Communities of Molecules (A Physical Chemistry Module)

* * * * *

TEXTBOOK

Ledbetter, et al. Keys to Chemistry, 1973; Addison-Wesley Publishing Company, Inc., Reading, Massachusetts 01867

LABORATORY MANUAL TO ACCOMPANY KEYS TO CHEMISTRY

Ledbetter, et al. Laboratory Keys to Chemistry.

TEXTBOOK

O'Connor, et al. *Chemistry: Experiments and Principles*, 1968; D. C. Heath and Company, Division of Raytheon Education Company, 285 Columbus Avenue, Boston, Massachusetts 02116

LABORATORY GUIDE TO ACCOMPANY CHEMISTRY: EXPERIMENTS AND PRINCIPLES

Davis, et al. Laboratory Manual of *Chemistry: Experiments and Principles*.

* * * * *

TEXTBOOK

Parry, et al. *Chemistry: Experimental Foundations*, 1970; Prentice-Hall, Inc., 70 Fifth Avenue, New York, New York 10011

LABORATORY GUIDE TO ACCOMPANY CHEMISTRY: EXPERIMENTAL FOUNDATIONS

Tellifsen, et al. Laboratory Manual, *Chemistry: Experimental Foundations*

* * * * *

TEXTBOOK

Smoot, et al. *Chemistry: A Modern Course*, 1971; Charles E. Merrill Publishing, Division of Bell and Howell Company, 1300 Alum Creek Drive, Columbus, Ohio 43216

LABORATORY GUIDE TO ACCOMPANY CHEMISTRY: A MODERN COURSE

Carmichael, et al. *Laboratory Chemistry*

TEXTBOOK

Toon, et al. Foundations of Chemistry, 1973; Holt, Rinehart, and Winston, Inc., 383 Madison Avenue, New York, New York 10017

LABORATORY GUIDE TO ACCOMPANY FOUNDATIONS OF CHEMISTRY

Toon, et al. Laboratory Experiments for Foundations of Chemistry

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TEXTBOOK AND LABORATORY GUIDE COMBINATION

Turner-Sears, et al. Inquiries in Chemistry, 1974; Allyn and Bacon, Inc., 470 Atlantic Avenue, Boston, Massachusetts 02210

APPENDIX I-B

REFERENCE CODE

Bickel '71 (Laboratory Guide)	Bickel, Charles L., et al. Chemistry, A Laboratory Approach. New York, New York: American Book Company, 1971
Bolton '73 (Laboratory Guide)	Bolton, et al. Laboratory Experiments in Action Chemistry. New York, New York: Holt, Rinehart, and Winston, 1973
Carmichael '71 (Laboratory Guide)	Carmichael, Neal et al. Laboratory Chemistry. Columbus, Ohio: Charles E. Merrill Publishing Division of Bell and Howell Company, 1971
Cotton '73 (Textbook-Laboratory Guide combination)	Cotton, F. A., et al. Chemistry - An Investigative Approach. Boston, Massachusetts: Houghton Mifflin Company, 1973
Davis '68 (Laboratory Guide)	Davis, Joseph E., et al. Laboratory Manual of Chemistry: Experiments and Principles. Boston, Massachusetts: D. C. Heath and Company, 1968
DeVoe '73 (One of a set of modules Textbook-Laboratory Guide combination)	DeVoe, Howard. Communities of Molecules, A Physical Chemistry Module. New York, New York: Harper and Row, Publishers, 1973
Ferguson '73 (Laboratory Guide)	Ferguson, Howard W. Laboratory Investigations in Chemistry. Park Ridge, Illinois: Silver Burdett Company, 1973
Gordon '73 (One of a set of modules. Textbooks-Laboratory Guide combination)	Gordon, Glen. The Delicate Balance, An Environmental Chemistry Module. New York, New York: Harper and Row, Publishers, 1973
O'Connor '68 (Textbook)	O'Connor, Paul R., et al. Chemistry: Experiments and Principles. Boston, Massachusetts: D. C. Heath and Company, 1968
Tellifsen '70 (Laboratory Guide)	Tellifsen, Robert L., et al. Laboratory Manual, Chemistry Experimental Foundations. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970

Toon '73 (Laboratory Guide)	Toon, Ellis et al. Laboratory Experiments for Foundations of Chemistry. New York, New York: Holt, Rinehart, and Winston, 1973
Turner '74 (Textbook-Laboratory Guide combination)	Turner, A. Mason et al. Inquiries in Chemistry. Boston, Massachusetts: Allyn and Bacon, 1974
Ledbetter '73	Ledbetter, Ealine W., et al. Laboratory Keys to Chemistry.

APPENDIX II

SIGNIFICANT DIGITS RATIONALIZED

(To be used if the usual analysis by uncertainties seems to be too rigorous for the class)

Multiplication-Division

Given that the dimensions of a rectangle are measured to be 13.21 in. by 7.3 in. Find the areas. Use significant digit rules in rounding off.

The last digit in any measured number is an estimated digit, meaning that it represents the best estimate we can make about where the real length of the rectangle lies between two of the smallest divisions on the ruler.

$$\begin{array}{r}
13.21\text{ in.}\\
\underline{7.3\text{ in.}}\\
3963\phantom{\text{ in.}}\\
\underline{9247\phantom{\text{ in.}}}\\
96.433\text{ in.}^2
\end{array}$$

We, according to significant digit rules, would report the area as 96 in.^{2}. This would mean that the 6 is an estimated digit. (It is proper to report answers calculated from measurements in such a way that they show all the known (not estimated) digits and one estimated one.) Recall that this is also the way we report measurements.

To rationalize, let us go back over the problem circling the estimated digits to see how the uncertainty spreads through the calculation. Remember that:

1. An estimate x an estimate gives another estimate.
2. An estimate x a known digit gives another estimate.

$$\begin{array}{rl}
13.2\textcircled{1}\text{ in.} & \\
\underline{7.\textcircled{3}\text{ in.}} & \\
\textcircled{3}\textcircled{9}\textcircled{6}\textcircled{3} & \leftarrow\text{These are all estimated because of multiplying by 3 which was an estimate}\\
\underline{924\textcircled{7}} & \leftarrow\text{The 7 is an estimate because of multiplying by 1 which was an estimate}\\
9\textcircled{6}.\textcircled{4}\textcircled{3}\textcircled{3} &
\end{array}$$

Now, if we report in our answer all the known digits plus one estimated one, we would round off, reporting 96 in.^{2} as the answer.

This is precisely the way we rounded off using significant digit rules.

(The teacher is warned that he must choose examples carefully as some will not work out so well.)

Addition-Subtraction

You cannot add an unknown quantity to a known or even to an estimated one.

Add

4.3 1 - in.
2.4 2 3 in.
6.0 - - in.

Obviously the measurements were not all made with the same ruler. The second measurement was made with the most precise ruler. The last one with the least precise ruler. Nothing is known about digits to the right of the first estimated digit in a measurement. If nothing is known about a digit, you cannot assume it to be 0.

Use a ? to represent an unknown digit.

4.3 1 ? ? in.
2.4 2 3 ? in.
6.0 ? ? ? in.

Round every number back to the first (counting from right) complete column.

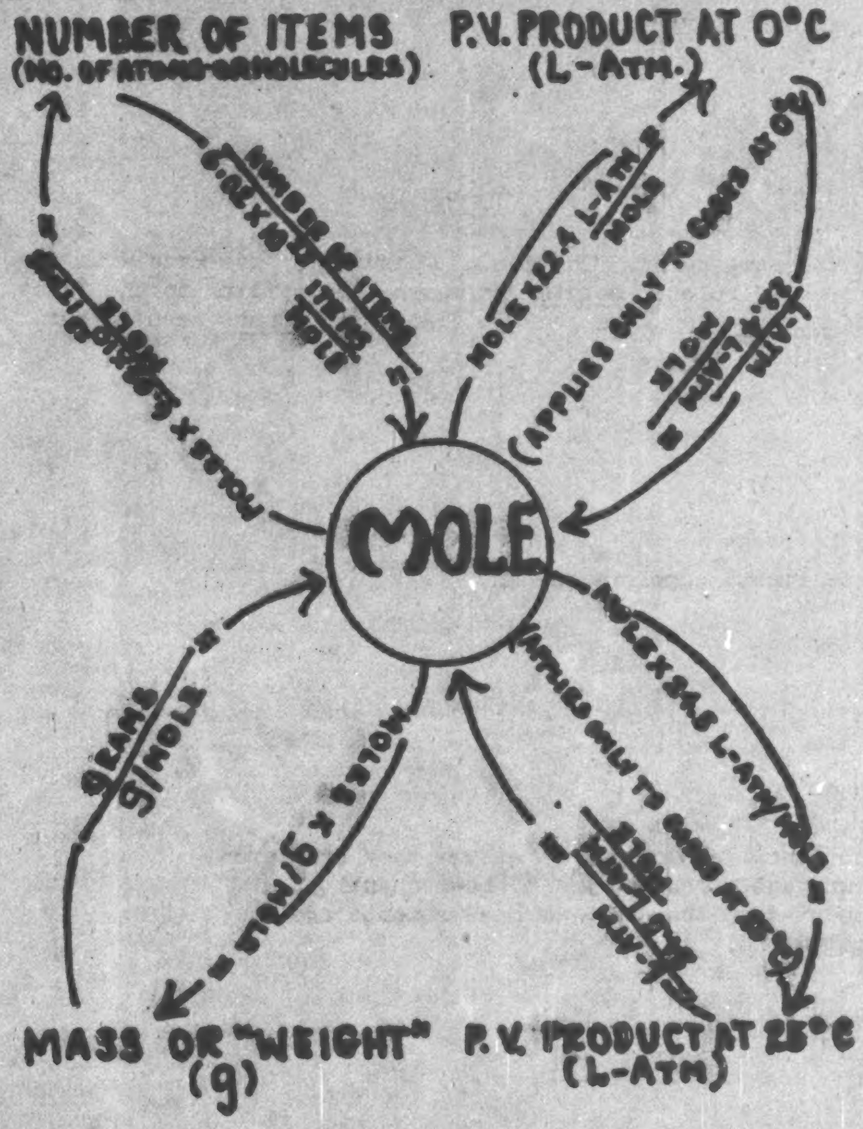
4.3 in.
2.4 in.
6.0 in.
1 2.7 in.

Rationale:

1. You know nothing about digits that are not shown so you cannot assume they are zeros.
2. You cannot add known quantities to unknown quantities and get a known quantity.
3. The answer to a calculation should be reported in the same way measurements are - with all the known digits plus one estimated one.

APPENDIX III

(A crutch to be used only during first few weeks of the course)


NUMBER OF ITEMS
(NO. OF ATOMS OR MOLECULES)
P.V. PRODUCT AT 0°C
(L-ATM.)
MOLES X 6.02 X 10 ITEMS/MOLE =
NUMBER OF ITEMS / 6.02 X 10 ITEMS/MOLE =
MOLE X 22.4 L-ATM/MOLE =
(APPLIES ONLY TO GASES AT 0°C)
L-ATM / 22.4 L-ATM/MOLE =
MOLE
GRAMS / g/MOLE =
MOLES X g/MOLE =
MOLES X 24.5 L-ATM/MOLE =
(APPLIES ONLY TO GASES AT 25°C)
L-ATM / 24.5 L-ATM/MOLE =
MASS OR "WEIGHT"
(g)
P.V. PRODUCT AT 25°C
(L-ATM)

$\frac{g}{MOLE}$ COMES FROM ATOMIC WEIGHT CHART

$\frac{g}{g/MOLE}$ IS THE SAME AS: $g \times \frac{MOLE}{g}$

$\frac{L\text{-}ATM}{L\text{-}ATM/MOLE}$ IS THE SAME AS: $L\text{-}ATM \times \frac{MOLE}{L\text{-}ATM}$

$\frac{ITEMS}{ITEMS/MOLE}$ IS THE SAME AS: $ITEMS \times \frac{MOLE}{ITEM}$

"ITEM" refers to number of atoms or number of molecules. Later in the course it refers to number of electrons.

APPENDIX IV

CAREERS IN SCIENCE AND TECHNOLOGY

With Sources of Information on Each
(See Appendix VII for addresses)

AGRICULTURE

1. Agricultural Engineering
   American Society of Agricultural Engineers

2. Animal Science
   American Society of Animal Science
   American Association for Laboratory Animal Science

3. Plant Sciences
   American Association of Nurserymen, Inc.

4. Soil Science
   Soil Conservation Service, U. S. Department of Agriculture

ANTHROPOLOGY AND ARCHAEOLOGY

Archaelogical Institute of America
American Anthropological Association

ARCHITECTURE

American Society of Landscape Architects

ASTRONOMY AND METEROLOGY

American Astronomical Society
American Meterological Society

ATOMIC ENERGY

U. S. Atomic Energy Commission

AVIATION AND SPACE SCIENCE

National Aerospace Education Association
National Aeronautics and Space Administration

BIOLOGICAL SCIENCES

1. Biology
   American Institute of Biological Sciences, Education Division
2. Cell Biology
   The American Society for Cell Biology
3. Microbiology
   American Society for Microbiology
   Food and Drug Administration
4. Pathology
   The Intersociety Committee on Pathology Information, Inc.
5. Pest Control
   National Pest Control Association
6. Zoology
   American Society of Zoologists

CHEMISTRY

1. Chemistry
   American Chemical Society
   Food and Drug Administration
   Manufacturing Chemists Association
2. Chemical Engineering
   American Institute of Chemical Engineers

CHEMISTRY (Cont d)

3. Biochemistry
   Educational Affairs Committee, American Society of Biological Chemists, Inc.

CONSERVATION AND ECOLOGY

Institute of Environmental Sciences
The Wild Life Society
U. S. Environmental Protection Agency
Water Pollution Control Federation

ELECTRONICS

1. Electronic Service Technician
   Electronic Industries Association

2. Computer Science
   International Business Machines Corporation
   U. S. Department of Labor

ENGINEERING

American Institute of Biological Sciences Bioinstrumentation Advisory Council (Biomedical Engineering)
American Institute of Chemical Engineers
American Institute of Industrial Engineers
American Society of Engineering Education
American Society of Civil Engineers
American Petroleum Institute
American Society of Safety Engineers
Engineers Joint Council

FORESTRY

American Forest Institute
Forest Service, U. S. Department of Agriculture

GEOLOGICAL SCIENCES AND OCEANOGRAPHY

American Geological Institute
Society of Exploration Geophysicists
Louisiana State University - The Center of Wetland Resources (Marine Science)
Marine Technology Society

GRAPHIC ARTS

International Typographic Composition Association
Eastman Kodak Company

INDUSTRIAL

Accoustical Society of America
American Industrial Hygiene Association
Plastics Education Foundation - The Society of the Plastics Industry, Inc.

MATHEMATICS

The Mathematical Association of America
Society for Industrial and Applied Mathematics

MEDICINE AND HEALTH

1. All Medical Fields
   - U. S. Department of Health, Education, and Welfare
   - American Hospital Association
   - American Public Health Association
   - American Medical Association

2. Careers Related to Health and Medicine
   - American Association of Clinical Chemists
   - National Environmental Health Association
   - American Association for Health, Physical Education, and Recreation
   - Health Physics Society

MEDICINE AND HEALTH (Cont'd)

3. Chiropractic
    American Chiropractic Association

4. Dentistry
    American Dental Association
    American Dental Hygienists' Association

5. Dietetics and Nutrition
    American Institute of Nutrition
    American Dietetic Association
    Institute of Food Technologists

6. Eye Care
    Opticians Association of America
    American Optometric Association
    American Association of Opthalmology

7. Medican Technology
    Registry of Medical Technologists (Medical Technologists, Cytotechnologists, Certified Laboratory Assistants)
    Society of Nuclear Medical Technologists

8. Mental Health
    The American Psychoanalytic Association
    National Association of Human Services Technologies (Psychiatric Technician)

9. Nursing
    American Nurses' Association, Inc.
    National League for Nursing, Inc.

10. Orthotic and Prosthetic
    American Orthotic and Prosthetic Association

11. Osteopathy
    American Osteopathic Association

12. Pharmacy
    American Association of Colleges of Pharmacy
    American Society for Pharmacology and Experimental Therapeutics, Inc.

MEDICINE AND HEALTH (Cont'd)

13. Physical Therapy
    - American Physical Therapy Association
    - American Association of Respiratory Therapy

14. Physiology
    - The American Physiological Society

15. Podiatry
    - The American Podiatry Association

16. Radiologic Technology
    - American Society of Radiologic Technologists

17. Veterinary Medicine
    - American Veterinary Medical Association

MINING AND METALLURGY

American Society for Metals
The Metallurgical Society
Society of Mining Engineers of AIME

PHOTOGRAPHY

The American Society of Photogrammetry
Eastman Kodak Company

PHYSICS

American Institute of Physics

TEACHING AND EDUCATION SERVICES

National Education Association

TECHNICAL WRITING

Society for Technical Communication

APPENDIX V

CAREERS RELATED TO SCIENCE

Level	Service	Business Clerical and Sales	Science and Technology	Outdoor	General Culture	Arts and Entertainment
I B.A. or ABOVE	Occupational Therapist Psychologist Psychiatrist Dietician Reg. Nurse	Sales Eng. Mfg. Electronic Equipment	Authropologist Chemist Med. Technologist Astronautic Engineer Physicist Engineer Mathematician Physician Biologist Botanist Veterinarian Pharmacist Nurse Dentist Chiropractor	Agronomist Wildlife Specialist Range Management Specialist Horticulturist City Agent Landscape Architect	Curator Science Teacher Phy. Ed. Teacher	
II H.S. PLUS TECHNICAL	Mortician *Practical Nurse	Pharm. Salesman *Med. Secy. Chem. Secy. Salesman Scientific Supplies & Equipment *Florist	Data Proc. Tech. *Data Programmer *Electrocard *Inhal. Therap. *Lineman *Pipefitter Const. *Radiologic Tech. *Dental Tech. Optometrist Med. Tech. *Prac. Nurse *Chem. Oper. *Dental Hygnst.	Flori-culturist Nurseryman Tree Surgeon Fish Culturist Soil Conservation *Constr. Tech.		Botanical Artist

*Included in V. I. E. W. File (Vital Information for Education and Work)

CAREERS RELATED TO SCIENCE

Level	Service	Business Clerical	Science and Technology	Outdoor	General Culture	Arts and Entertainment
III H.S. GRADUATE	Masseur Barber Dent. Hyg. Food Ser. Worker Hosp. Ord. Nurse Aide Phy. Therap.	Library Asst. Med.	Dk. Room Tech. Encephal. Sanitarn. Aide Taxidermist Dry Cleaner Lab. Tech. Baker	Landscape Gardener Poultryman Truck Gardener Apiarist		
IV LESS THAN H.S. GRADUATE	*Beauty Operator		Vet. Hosp. Attendant Zoo Caretkr. Nurse Aide *Prosthetic	Lumber Inspector Nursery Employees		*Animal Trainer Photo. Tech.

*Included in V. I. E. W. file (Vital Information for Education and Work)
For further information about any job title, see your counselor

APPENDIX VI

OCCUPATIONAL STUDY OUTLINE

A. NAME OF OCCUPATION:

B. DUTIES OF THE OCCUPATION:

C. QUALIFICATIONS: What are the personal requirements?

D. AGE: How old must I be to enter the occupation?

E. SEX: Is this an occupation in which others of my sex are normally employed?

F. SPECIFIC PHYSICAL AND HEALTH REQUIREMENTS: Am I correct height to do the work? Are my eyesight and hearing adequate? Am I strong enough?

G. INTEREST: Do I possess this interest? If not, could I develop interest in this type of work? Would I be happy doing this type of work?

H. ABILITIES: Do I possess the required abilities? If not, could I acquire the knowledge and skills necessary to do the job?

I. PERSONALITY: Do I possess the personal qualities necessary for doing this type of work? If not, could I develop these qualities?

J. VALUES AND ATTITUDES: Does anything about this job violate values and attitudes I have about people and work? If so, could I adjust to situtions that required I change my values and attitudes?.

K. PREPARATION: What subjects do I need to study? What special training will I need? How long will it take to receive this training? How much will it cost? Can I get this training within the state? Is work experience required for entry into this occupation? What is the method of entry into this occupation? Are any scholarships available for the education required?

L. WORKING CONDITIONS ON THE JOB: Is it hazardous work? Is it noisy or dirty? Will I work alone or with a group? Does the work require being away from home for long periods of time?

M. EMPLOYMENT OPPORTUNITIES: How much is the beginning pay? What is the salary range? What are the opportunities for advancement? Will additional education be needed for promotions? If so, will the employer offer any assistance in additional education?

N. EMPLOYMENT OUTLOOK: How many are employed in the occupation at present? Are there employment opportunities in my community or state for this type of work?

O. SPECIAL REQUIREMENTS: (Such as certification, licenses, and examinations)

APPENDIX VII

ADDRESSES

Accoustical Society of America
335 East 45th Street
New York, NY   10017

American Anthropological Association
1703 New Hampshire Avenue, NW
Washington, DC   20009

American Association for Health,
  Physical Education, and Recreation
1201 16th Street, NW
Washington, DC   20036

American Association for Laboratory
  Animal Science
2317 W. Jefferson Street, Suite 208
Joliet, IL   60435

American Association for
  Respiratory Therapy
7411 Hines Place
Dallas, TX   75235

American Association of Clinical Chemists
P. O. Box 15053
Winston Salem, NC   27103

American Association of Colleges
  of Pharmacy
Office of Student Affairs
8121 Georgia Avenue, Suite 800
Silver Springs, MD   20910

American Association of Nurserymen
835 Southern Building
Washington, DC   20005

American Association of Opthalmology
1100 17th Street, NW
Washington, DC   20036

American Astronomical Society
211 Fitz Randolph Road
Princeton, NJ   08540

American Chemical Society
Education Office
1155 G 16th Street, NW
Washington, DC   20036

American Chiropractic Association
Department of Education
2200 Grand Avenue
Des Moines, IA   50312

American Dental Assistants Association
311 East Chicago Avenue
Chicago, IL   60611

American Dental Association
Council on Dental Education
211 East Chicago Avenue
Chicago, Il   60611

American Dental Hygienists' Association
211 East Chicago Avenue
Chicago, IL   60611

The American Dietetic Association
620 North Michigan Avenue
Chicago, IL   60611

American Forest Institute
1619 Massachusetts Avenue, NW
Washington, DC   20036

American Geological Institute
2201 M Street, NW
Washington, DC 20037

American Hospital Association
840 North Lake Shore Drive
Chicago, IL 60611

American Industrial Hygiene Association
66 South Miller Road
Akron, OH 44313

American Institute of Biological Sciences
Bioinstrumentation Advisory Council
3900 Wisconsin Avenue, NW
Washington, DC 20016

American Institute of Chemical Engineers
345 East 47th Street
New York, NY 10017

American Institute of Industrial
  Engineers, Inc.
25 Technology Park
Atlanta, GA 30071

American Institute of Landscape Architects
6810 North 2nd Place
Phoenix, AZ 85012

American Institute of Nutrition
9650 Rockville Pike
Bethesda, MD 20014

American Institute of Physics
355 East 45th Street
New York, NY 10017

American Medical Association
Order Institute
535 North Dearborn Street
Chicago, IL 60611

American Meterological Society
45 Beacon Street
Boston, MA 02108

American Nurses Association, Inc.
2420 Pershing Road
Kansas City, MO 64108

American Optometric Association
700 Chippewa Street
St. Louis, MO 63119

American Orthotic and Prosthetic
  Association
1440 N Street, NW
Washington, DC 20005

American Osteopathic Association
212 E. Ohio Street
Chicago, IL 60611

American Petroleum Institute
Publications and Distribution
1801 K Street, NW
Washington, DC 20006

American Physical Therapy Association
1156 15th Street, NW
Suite 500
Washington, DC 20005

American Physiological Society
9650 Rockville Pike
Bethesda, MD 20014

American Podiatry Association
20 Chevy Chase Circle, NW
Washington, DC 20015

American Psychoanalytic Association
One East Fifty-Seventh Street
New York, NY 10022

American Public Health Association
1015 18th Street, NW
Washington, DC 20036

American Society for Cell Biology
Department of Anatomy
Albert Einstein College of Medicine
1300 Morris Park Avenue
Bronx, NY 10461

American Society for Engineering Education
Suite 400
One Depont Circle
Washington, DC 20036

American Society for Metals
Metals Park, OH 44073

American Society for Microbiology
1913 Eye Street, NW
Washington, DC 20006

American Society for Pharmacology
and Experimental Therapeutics, Inc.
9650 Rockville Pike
Bethesda, MD 20014

American Society of Agricultural Engineers
2950 Niles Road
St. Joseph, MI 49085

American Society of Animal Science
39 Sheridan Avenue
Albany, NY 12210

American Society of Civil Engineers
345 East 47th Street
New York, NY 10017

American Society of Landscape Architects
1750 Old Meadow Road
McLean, VA 22101

The American Society of Photogrammetry
105 N. Virginia Avenue
Falls Church, VA 22046

The American Society of Radiologic
Technologists
645 North Michigan Avenue, Room 620
Chicago, IL 60611

American Society of Safety Engineers
850 Busse Highway
Park Ridge, IL 60068

American Society of Zoologists
Box 2739
California Lutheran College
Thousand Oaks, CA 91360

American Technical Society
848 E. 58th Street
Chicago, IL 60637

American Veterinary Medical Association
600 South Michigan Avenue
Chicago, IL 60605

Archaeological Institute of America
260 W. Broadway
New York, NY 10013

Barron's Educational Series, Inc.
113 Crossways Park Drive
Woodbury, NY 11797

B'nai B'rith Career and Counseling
Services
1640 Rhode Island Avenue, NW
Washington, DC 20036

Careers (Career Publications)
Box 135
Largo, FL 33540

Chronicle Guidance Publications
Moravia, NY 13118

E. P. Dutton & Company, Inc.
201 Park Avenue, South
New York, NY 10003

Eastman Kodak Company
343 State Street
Rochester, NY 14612

Educational Affairs Committee
American Society of Biological
  Chemists, Inc.
9650 Rockville Pike
Bethesda, MD 20014

Electronic Industries Association
2001 Eye Street, NW
Washington, DC 20006

Engineers' Council for Professional
  Development
345 East 47th Street
New York, NY 10017

Engineers Joint Council
345 East 47th Street
New York, NY 10017

Harper & Row, Publishers, Inc.
10 East 53rd Street
New York, NY 10022

Health Physics Society
P. O. Box 155
E. Weymouth, MA 02189

Institute of Environmental Sciences
940 East Northwest Highway
Mt. Prospect, IL 60056

The Institute of Food Technologists
221 North LaSalle Street
Chicago, IL 60601

International Business Machines
  Corporation
Armonk, NY 10504

International Typographic Composition
  Association, Inc.
2233 Wisconsin Avenue, NW
Washington, DC 20007

The Intersociety Committee on
  Pathology Information, Inc.
9650 Rockville Pike
Bethesda, MD 20014

Louisiana State University
The Center for Wetland Resources
Baton Rouge, LA 70803

Louisiana State Department of
  Commerce and Industry
State Land and Natural Resources Building
Baton Rouge, LA 70804

Manufacturing Chemists Association
1825 Connecticut Avenue, NW
Washington, DC 20009

Marine Technology Society
1730 M Street, NW
Washington, DC 20036

The Mathematical Association
  of America
1225 Connecticut Avenue, NW
Washington, DC 20036

Julian Messner
Division of Simon & Schuster, Inc.
1 West 39th Street
New York, NY 10018

The Metallurgical Society of AIME
345 East 47th Street
New York, NY 10017

National Aerospace Education
Association
806 15th Street, NW
Washington, DC 20005

National Association of Human
Services Technologies
1127 11th Street
Sacramento, CA 95814

National Education Association
Customer Service Section 81
1201 16th Street, NW
Washington, DC 20036

National Environmental Health
Association
1600 Pennsylvania Avenue
Denver, CO 80203

National Health Council
1740 Broadway
New York, NY 10019

National League for Nursing, Inc.
10 Columbus Circle
New York, NY 10019

National Pest Control Association
(The Buettner Building)
250 West Jersey Street
Elizabeth, NJ 07207

National Science Teachers Association
1201 16th Street, NW
Washington, DC 20036

Northwestern State University
Institute of Technology
Natchitoches, LA 71457

Opticians Association of America
1250 Connecticut Avenue, NW
Washington, DC 20036

Registry of Medical Technologists
P. O. Box 4872
Chicago, IL 60680

Science Research Associates, Inc.
Guidance Services Department
259 E. Erie Street
Chicago, IL 60611

Scientific Manpower Commission
2100 Pennsylvania Avenue, NW
Washington, DC 20037

Society for Industrial and
Applied Mathematics
33 South 17th Street
Philadelphia, PA 19103

Society for Technical Communications
Suite 421
1010 Vermont Avenue, NW
Washington, DC 20005

The Society of Exploration Geophysicists
Howard Breck, Executive Secretary
Box 3098
Tulsa, OK 74101

The Society of Mining Engineers of AIME
345 East 47th Street
New York, NY 10017

Society of Nuclear Medical Technologists
P. O. Box 284
Arlington Heights, IL 60006

Student American Medical Association
Women in Medicine
Committee of the Medical College
of Pennsylvania
Philadelphia, PA 19129

Technical Education Research Centers
44 Brattle Street
Cambridge, MA 02138

VITAL Career Information Center
P. O. Box 44064
Baton Rouge, LA 70804

Vocational Guidance Manuals
235 East 45th Street
New York, NY 10017

The Wildlife Society
3900 Wisconsin Avenue, NW
Washington, DC 20016

Water Pollution Control Federation
3900 Wisconsin Avenue, NW
Washington, DC 20016

U. S. GOVERNMENT AGENCIES

National Aeronautics and Space
  Administration
Counseling and Career Guidance Officer
  Code FE, Educational Programs Division
Office of Public Affairs
Washington, DC 20546

U. S. Atomic Energy Commission
Division of Technical Information
Box 62
Oak Ridge, TN 37830

U. S. Civil Service Commission
Washington Area Office
Washington, DC 20415

Forest Service
U. S. Department of Agriculture
Washington, DC 20250

Soil Conservation Service
U. S. Department of Agriculture
Washington, DC 20251

U. S. Department of Health, Education
  and Welfare
Public Health Service
Food and Drug Administration
Consumer Affairs Staff
5600 Fishers Lane
Rockville, MD 20852

U. S. Department of Health, Education
  and Welfare
Public Health Service
National Institutes of Health
Division of Physical and Health
  Professions Education
Bureau of Health Manpower Education
Bethesda, MD 20014

U. S. Department of Labor
Bureau of Labor Statistics
Washington, DC 20212

U. S. Environmental Protection Agency
Personnel Management Division
Personnel Operations Branch
Waterside Mall Building
401 M Street, SW
Washington, DC 20460

U. S. Office of Education and Training
Smithsonian Institution
Washington, DC 20560